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THE GROOVELESS TRAMWAY.

We here illustrate a system of tramway by Mr. Charles A. Edge, Birmingham, Eng. We have already described this tramway, and expressed a very favorable opinion concerning it which experience has justified. We now illustrate it as adopted in the city of Brunswick, where a length of two miles has been laid, and successfully worked for the last two months.

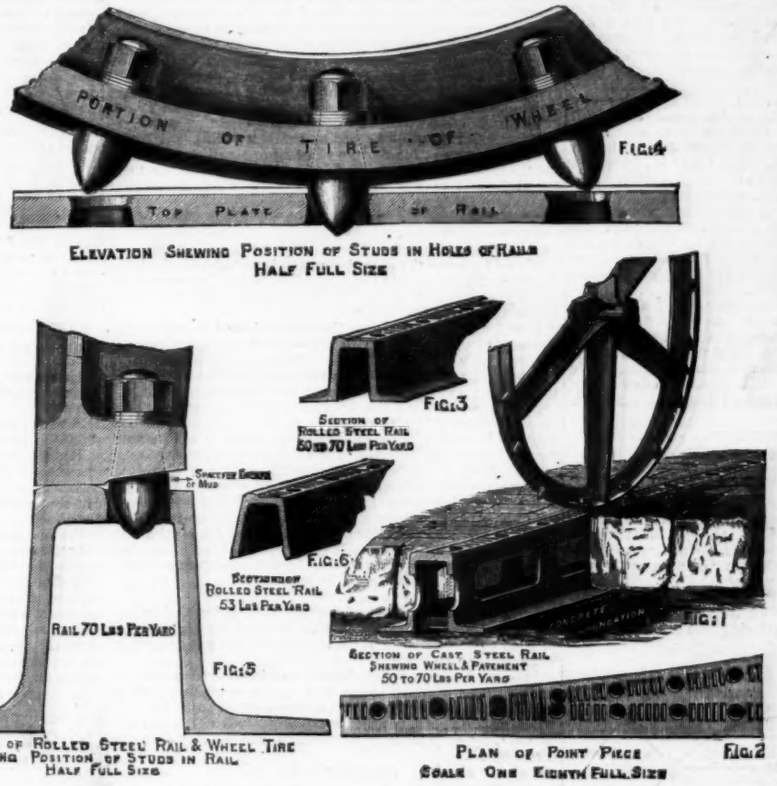
The cars have made over 3,000 journeys, equal to 10,000 traffic miles, without an accident, and with no perceptible wear either of the wheels or rails. The "Kreismeister," or city surveyor, certifies, "The rails with grooves have given no interference either to heavy or light vehicles, nor to foot traffic." And a local paper, referring to the running, remarks, "The cars move along with the same quiet ease and smoothness as in the old system, and the friction is apparently less."

The rails are of cast steel, as shown in Fig. 1, and the wheels are Hadfield's crucible cast steel, as shown in Figs. 3, 4, and 5, fitted with movable studs of hardened Bessemer steel.

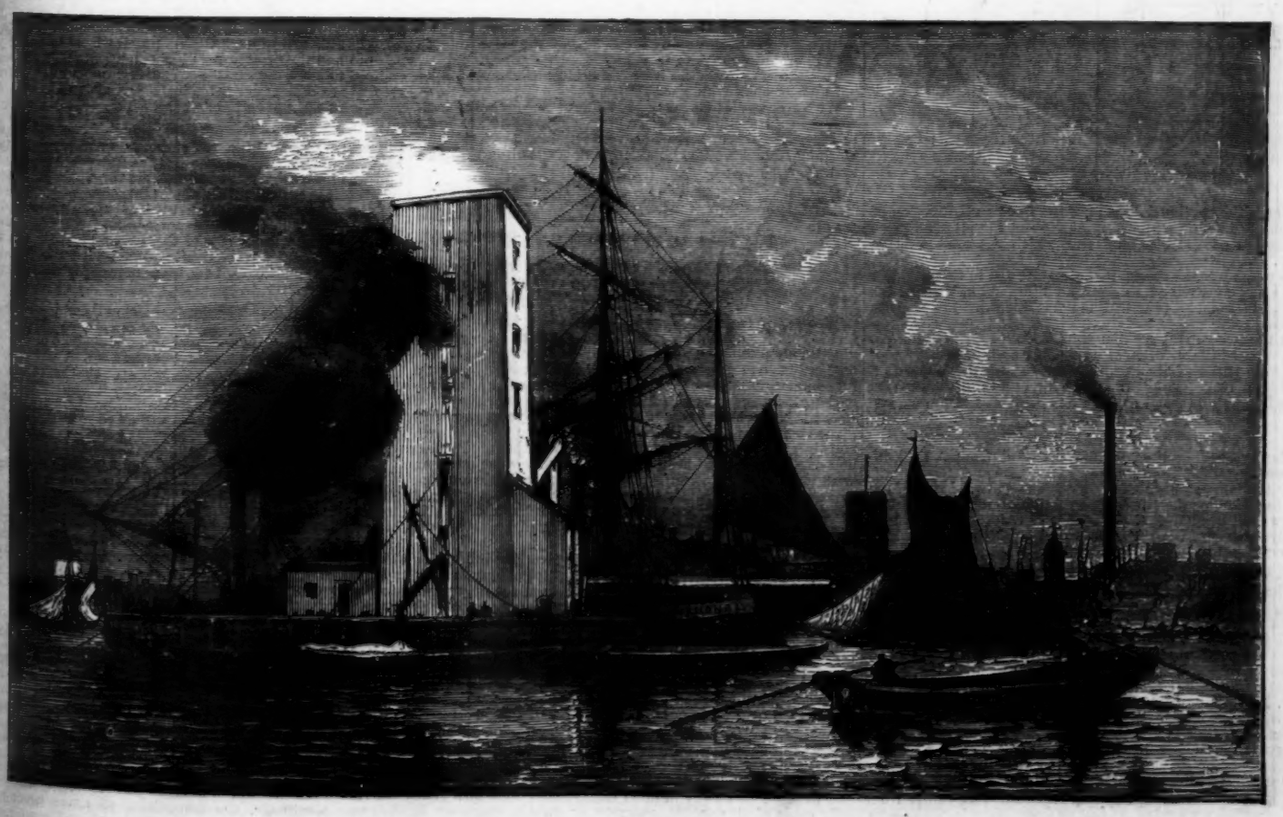
There are only two cars running at present, and with these have been carried 70,000 passengers. Two more cars will be ready for use in a few days, and the remainder of the line, about five miles long, will be proceeded with as soon as the weather will permit. The studs are fitted to only two wheels on one side of the car, and both rails are alike. The wheel base of the existing cars is 5 ft. 6 in. long with bogies, and the gauge is 3 ft. 5 in. from center to center of the holes in the rails. The new car will have a 4 ft. fixed wheel base, and be worked with one horse, and constructed to carry sixteen passengers. The present cars carry twenty-six with driver and conductor, which is too much for one horse up inclines of about 1 in 40. The distances are too short to make it worth while to have an odd horse for the hills.

The winter has been very severe, and the dirt in the holes and the chamber under that part the rails not filled up with concrete and earth at first, has been frozen almost as hard as iron during half the time the line has been open. But this has not interfered with the running of the cars in any way, nor has the snow, which has several times reached a depth of 12 in.; the cars have never been derailed, although snow accumulating in hard masses made the line run very uneven.

This system deserves the attention of borough engineers, as it seems to be the best solution yet produced of the problem how to lay down a tramway which will not prejudicially affect ordinary light vehicles like broughams and cabs, and the success which has so far been attained in Brunswick augurs well for the future of Mr. Edge's ingenious invention. — *The Engineer.*


PORTION OF TIRE OF WHEEL
FIG. 4
TOP PLATE OF RAIL
ELEVATION SHEWING POSITION OF STUDS IN HOLES OF RAILS
HALF FULL SIZE
FIG. 3
SECTION OF ROLLED STEEL RAIL 50 TO 70 LBS PER YARD
SPECIFIED DEPTH OF MUD
FIG. 6
SECTION OF ROLLED STEEL RAIL 53 LBS PER YARD
RAIL 70 LBS PER YARD
FIG. 5
CONCRETE
FIG. 1
SECTION OF CAST STEEL RAIL SHEWING WHEEL & PAVEMENT 50 TO 70 LBS PER YARD
SECTION OF ROLLED STEEL RAIL & WHEEL TIRE SHEWING POSITION OF STUDS IN RAIL HALF FULL SIZE
PLAN OF POINT PIECE SCALE ONE EIGHTH FULL SIZE
FIG. 2

EDGE'S GROOVELESS TRAMWAY, BRUNSWICK.



AMERICAN GRAIN ELEVATOR IN LONDON.

THE AMERICAN GRAIN ELEVATOR IN LONDON.

THE system of loading and unloading grain ships by steam has been very successfully carried out in the United States, and it was by the request of the corn trade or Mark Lane interest that the elevator now working off North Woolwich was brought over, and got into real active service. So strange a structure moored in the river caused much excitement among the water population, and the tower of corrugated zinc was supposed by some to be tin packing cases going from Woolwich to bring home Cetewayo; while others mistook it for a new floating parish church.

The illustration shows the first vessel, the Georgia, alongside. She is an American bark of about 600 tons. The process adopted for extracting the corn is that of dredging; in some parts of America suction has been tried, and is in use, but dredging is simpler and more effective where the vessel comes alongside. The extracting leg comes out of the side of the tower; the knee-joint of it being raised or lowered by a very strong tackle; and it is from the knee-joint down to the foot of the leg that the dredges run and bring the grain out of the hold. The grain thus brought up is discharged into a pipe running into the tower, on its arrival there it is winnowed, cleaned, and carefully weighed, and then either measured off into sacks or delivered into barges, as may be desired The whole is done by self-acting machinery, and must be successful here, as it has been so thoroughly tried in New York and in Chicago also.

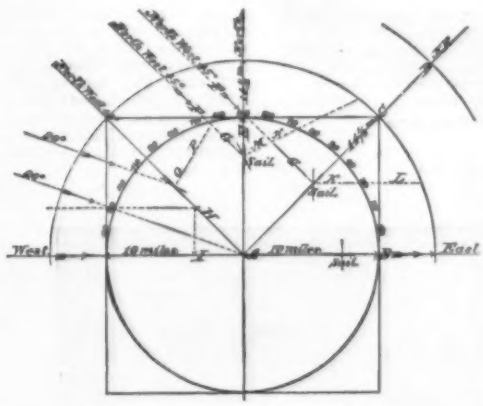
The economy of time is wonderful; by the grain elevators the work can be done in one-sixth of the usual time, and the height of the tower allows them to move about and raise and deliver the grain to any height required, either in warehouse or river-side granaries. The tower is eighty feet in height, and the illustration shows the grain pouring into the barges from the discharge pipe, which receives the grain clean and properly winnowed as it passes from the extracting leg, which dredges it up from the hold of the ship. In the examination of the millwrights' work on board, we are struck by the size of the American maple used for the shovels to feed the dredgers. Again some of the fine pine slabs are of immense size and without a knot.

We must congratulate Mr. Chippendale, of Mark Lane, on the successful issue of his energy. As the first ship came alongside the whole machinery worked straight off without any hitch, heating, or breakdown. The whole of the millwright work was done in America and sent over here. We have learnt many good things from America in labor-saving machines. This is certainly not one of the least practical. —*London Graphic.*

SPEED OF ICE YACHTS.

To the Editor of the Scientific American :

I have noticed in several numbers of the SCIENTIFIC AMERICAN SUPPLEMENT various articles for, and some against, the problem of ice yachts sailing faster than the velocity of the wind which moves them; and in a late SUPPLEMENT, No. 214, Feb. 7, are a number of articles illustrating the paradox by diagrams, from which I notice that one of the main elements involved in the matter is not considered in nearly all of them, and not fully considered in any of them. The difficulty in considering and illustrating this



matter is the continual change of the force and direction of action of the wind with every change of direction and rate of motion of the boat and sail which the wind is acting upon.

So much interest seems to be manifested in this problem that I am constrained to offer an illustration, treating the matter in a more practical manner than by the articles referred to.

In the accompanying diagram, A B represents the direction of a constant, even, steady wind; and, for future convenience, will call its direction west to east, moving with a velocity of, say, twenty miles per hour, and the distance from A to B ten miles, and will assume the boat has but one sail.

POSITION FIRST.

The boat sailing directly with the wind from A to B, direction east, distance ten miles.

As there must be some action on the windward side of the sail to overcome the friction of motion of the boat over the ice, we must assume that the boat cannot sail as fast directly with the wind as the velocity of the wind which moves it.

POSITION SECOND.

The boat sailing from A to C and D, direction N.E., or 45° from the direction of the west wind, which is moving twenty miles per hour, we will assume that the boat sails from A to C, in the same time the wind moves from A to B, which gives the boat a speed of 14¼ miles, while the due west wind is moving ten miles.

In this case, the boat running half way between north and east, is moving northward and eastward at the same rate the wind is moving east, consequently bringing the direction of action of the wind on the sail at a right angle to the boat's direction, or square on the beam (line F G). Any change in the speed of the boat will change the direction of action of the wind acting upon it.

The sail in this case is moving eastward or leewardly from the constant west wind, as fast or faster than in the case of A to B, Position First; and by the changed angle of the sail, with the acting direction of the wind, only about three-quarters of the horizontal breadth of the column of wind is acting on the sail which was acting in Position First, or A to B. The direction of action on the sail is due east, or at a right angle with the sail (line K L), which direction of action is 45° from the line of the boat's direction. For these apparent losses in force we must find more than an equivalent or fail to reach the point, C, 14¼ miles, while the constant west wind moves from A to B. This gain in force we find supplied by the changed direction of action, and consequent increased force, of the wind, which is now acting on the sail one-quarter reduced in breadth with a force due a velocity of over twenty miles per hour of wind, which is more than an equivalent for all apparent losses; and there can be no question that the boat may easily be made to reach the point, C, in the same time the wind passes from A to B; and with well-reduced friction of boat-runners, smooth ice, and small surfaces presented to the resistance of the changing current of wind, due to increase of speed when reaching beyond the point, C, in the given time, there can be no reasonable doubt that the boat may reach the point, D (twenty miles), or even farther, under the most favorable circumstances, while the west wind passes from A to B. In Positions First and Second the sails of both boats are at right angles to the west wind; both of the boats are moving eastwardly, and theoretically leaving the west wind at about the same rate, the boat in Position Second moves more than four miles more distance than the other. To account for these results we must take the direction of action of the wind on the boat, as shown and explained in Position Two.

The limit of speed of the boat in any direction between the line A C and 30°-or 45° north of west is fixed by bringing the direction of action of the wind more ahead, by increasing the speed of the boat, by friction of runners on the ice, the resistance of surfaces of boat, spars, rigging, and the persons on the boat, presented to the increased action of the wind due to increased speed of the boat.

POSITION THREE.

We will assume the direction of the boat to be north, A to E, and at right angles to the west wind, and will assume that the boat moves from A to E in the same time the west wind moves from A to B.

It will be seen in this case that the action of the wind on the sail is from a direction 45° forward of the beam or line of the boat's direction (line F G), making a necessity for trimming the sail well aft, or so near edge to the line of action of the wind as to allow but a narrow column of wind, say less than half of the breadth which was acting when running from A to C (Position Second); but this narrow column is acting with an increased force, due to about twenty-eight miles velocity of wind, which action has been increased by the assumed speed and direction of the boat, and velocity of the twenty miles constant west wind. As an offset to this increased force of wind we have the reduced column of wind acting on the angling sail, the unfavorable direction of its action, it being over 60° away from the line of the boat's direction (line M N); and to these offsets we may add the resistance of surfaces presented to the wind, which, at this assumed speed, is meeting the boat at 45° forward of the beam.

With all things considered in this case, and with friction on the ice favorable, it is probable the boat may sail as fast or even some faster than the motion of the constant west wind which propels it.

In considering the question of turning to windward or sailing *by* the wind, we must not ignore the constant west wind and its assumed velocity, or we may be sailing *by* the wind, or close haul, in any direction between north and 40° of west, by only increase of speed of boat in any of these directions.

POSITION FOUR.

Will assume a direction 45° from the line of the west wind (north west), and will assume a speed of ten miles per hour, velocity of wind twenty miles. With this assumed speed the boat will move from A to H, while the wind passes from A to B. The boat in moving five miles northwest has moved northerly from an east and west line a distance equal to I to H, consequently bringing the action of the west wind on the sail from 20° north of west.

This showing gives the boat something over seven miles per hour of clear windward attainment.

With stronger winds and nearly flat plane surface of sail, well-reduced friction on the ice and small surfaces presented to the resistance of the wind, very much better windward working results may be obtained than is shown in this position.

H. N. THROOP.

PULTNEYVILLE, Wayne Co., N. Y.

FIXED AND MOVABLE WEIRS.

AT a recent meeting of the Institution of Civil Engineers, London, the paper read was that of Mr. L. F. Vernon-Harcourt, M.A., M. Inst. C.E., on the above subject.

Weirs were employed for raising the water level of a river for navigation, for irrigation, or for mills. A weir was placed across the secondary channel of a river, when the navigation channel was occupied by a lock; and it served for maintaining the water above at the proper level for navigation, the discharge of the river flowing over the weir. Weirs constructed on the Severn about forty years ago were placed obliquely across the stream to increase their length, and thus to insure a greater discharge over them. Pointed and curved weirs had been often used for the same purpose, with the additional advantage of keeping the main current in a central channel. These weirs, which might be termed overfall weirs, were commonly formed of a bank of rubble stone, protected on the face by pitching, and secured from undermining by sheet piles.

Draw-door weirs had frequently to be provided in addition to overfall weirs, to give sufficient outlet for a river in time of flood. A draw-door weir consisted of a series of upright posts, placed at regular intervals across a portion of the stream, between which panels or doors slid in grooves, and were raised or lowered from a foot bridge above. Teddington weir furnished a fine example of a composite overfall and draw-door weir placed very obliquely across the Thames. Small draw-door weirs, as well as overfalls, were generally constructed at water mills for regulating the flow of the stream.

Overfall weirs, called anicuts, had been erected across several Indian rivers, to preserve and divert water for irrigation. Formerly, they consisted of embankments of sand or loose stones, which held up the water in the dry season and were washed away in flood time. They were now generally made of dry rubble, concrete, or rubble stone set in cement, protected on the face by pitching or ashlar, with a flat slope on the down-stream side. Sluices at the side served to discharge any excess of water and to remove silt. The Godavery anicut had a total length of 2½ miles, and the Dehree anicut was 2¼ miles long. Some of the weirs in Northern India had piers in the central portion, with intervals between them, which were closed by planks sliding down grooves in the piers, or sometimes by gates turning on a horizontal axis on the floor level. These open weirs were termed dams in India, and resembled draw-door weirs and M. Thénard's movable shutter weir. Dams cost less than anicuts, interfered less with the flow of the river, and prevented the accumulation of silt above the weir.

A brief history and description followed of the various kinds of movable weirs erected on some rivers in France and in Belgium. There were no instances, as far as the author was aware, of similar weirs in England; and very little information was given about them in the "Proceedings" of the Institution, or in other English publications. Movable weirs were barriers placed across a river to keep up the water level in dry seasons; and they were frequently employed for conducting the navigation intermittently by flushing. This consisted in producing a temporary artificial flood by the sudden opening of the weir, by which a convoy of boats, collected above the weir, were floated over the shallows below. In time of flood these weirs were entirely removed so as to present no obstruction to the flow.

There were five different types of movable weirs: (1) The Bear Trap; (2) M. Poirée's Frame or Needle Weir; (3) M. Chanoine's Shutter Weir; (4) M. Desfontaine's Drum Weir; and (5) M. Krantz's Pontoon Weir.

1. *The Bear Trap.*—The first weir of this type was erected on the Lehigh River, Pennsylvania, in 1818, and had since been introduced into France at Laneuville-au-Pont on the Marne. It consisted of two gates turning on horizontal axes at the bottom and inclined to one another when raised, the upper gate resting on the top edge of the lower gate. When the weir was lowered, the up-stream gate lay flat on the down-stream gate. The gates were raised by introducing water under them from the upper pool, and lowered by letting the water below them flow away into the lower pool, the sluice gate communicating with the upper pool having been shut.

2. *Frame or Needle Weir.*—This system consisted of a series of wrought-iron frames, placed parallel to the current, turning on hinges fixed to the apron, and connected and secured when standing upright by movable horizontal iron bars. Wooden spars or needles, resting against the sill at the bottom and against the horizontal bars at the top, formed the dam which kept up the water. The frames were placed about 3½ feet apart, and carried a footway on the top, on which the weir keeper stood to remove or replace the needles. When the river was in flood the needles having been removed, the frames could be laid flat on the apron. The first needle weir was erected on the Yonne in 1834, and since then the system had been introduced on several rivers in France, and on the Meuse in Belgium. This system was not well suited for high weirs, on account of the great increase in weight of the needles. Accordingly at Notre-Dame-de-la-Garonne the needles had been replaced by a sort of shutter, formed of a series of horizontal boards jointed together, which slid between the front part of the frames, and which could be rolled up when the weir was to be opened. M. Boule had used a series of horizontal boards for the same purpose, which could be lifted successively by a crab on the foot bridge.

3. *Movable Shutter Weir.*—This consisted of a gate or shutter, turning on a horizontal axis a little below half its height, supported on the top of a wrought-iron trestle hinged to the apron of the weir. When the weir was closed the trestle was upright, the shutter abutted at the bottom against a sill, and was supported in that position by a wrought-iron prop, hinged to the trestle, inclined at an angle of 45°, and resting at the bottom in a cast-iron shoe, from which it could be released by a sideways pull produced by a bar with projections. When the prop was released it slid down the apron, and the trestle and shutter fell flat upon it. The weir was raised by pulling up the shutter to a horizontal position by a chain attached to its lower end, and when the trestle was upright and the prop in position the pressure of the water sufficed to close the shutter. The first of these weirs was erected at Conflans-sur-Seine in 1858; and several others had since been put up on the Seine, the Yonne, and the Marne.

4. *Drum Weir.*—This was composed of two paddles able to make a quarter of a revolution round a horizontal axis between them. The upper paddle formed the weir gate, and was moved by water, let in from the upper pool into a recess below the sill, called the drum, acting upon the lower paddle, causing it to revolve. The weir was closed or opened according as the water was admitted into the drum on the upper or lower side of the lower paddle. The first weir of this kind was erected at Damery on the Marne in 1857: and similar ones had been used at several overfall weirs on that river.

5. *Pontoon Weir.*—The shutter closing the weir was hinged to a wrought iron pontoon floating in a cast-iron conduit, and hinged to the lower side of it, both pontoon and shutter revolving on horizontal axes. When the weir was open the pontoon lay flat in the conduit, with the shutter resting flat upon it. To close the weir, water was let into the conduit from a reservoir at a higher level. The pressure of the water raised the pontoon, which revolved on its axis at the lower end and raised the shutter. A weir of this construction had been commenced at Port Villez on the Seine; but some experiments at Bougival indicating a difficulty in working it, this type of weir was abandoned at that place.

The Bear Trap weir was complicated and not suitable for high weirs. The drum weir was only applicable for overfalls on account of the depth below the sill required for the drum. The Needle and Shutter weirs had been the most extensively adopted, and were the best types of movable weirs. The simplicity of the needle weir rendered it preferable for low weirs across rivers with continuous navigation and even flow; but the shutter weir was the most suitable for high weirs across rapid rivers, and where the navigation was conducted by flushing.

The neglect and silting up of rivers and the extension of subsoil drainage were the causes of the floods which so often occurred in river valleys. The existing river channels being unable to carry off the flood waters, even in summer, must be enlarged. This could be done by raising banks at the sides, or by increasing the depth and width of the channel. The first plan, though cheaper in the first instance, had led, in the long run, to so many disasters that the author was convinced that except in districts like the fens, where no fall was obtainable, the embanking of rivers beyond the tidal portion of their course was unadvisable. The alteration of existing weirs must form a part of any scheme for mit-

gating floods, and additional weirs would be needed if the river bed was lowered, in order to keep up the water-level in summer for the sake of the adjacent lands. Movable weirs when lowered presented no obstruction to the stream; they could be carried to greater depths than the ordinary type of fixed weirs, and they could be made self-acting. In conclusion, the author expressed the opinion that movable weirs, which had been successfully adopted in France for a long time, were worthy of the notice of English engineers.

The second paper was by Mr. R. B Buckley, Assoc. M. Inst. C.E., on

MOVABLE DAMS IN INDIAN WEIRS.

This paper commenced with a brief description of Indian weirs, and then proceeded to show the necessity for having portions of these weirs movable, so that the silt and deposits of different kinds might be swept away from the heads of the canals supplied from the rivers above the weirs. A description was given of the form of movable weir which had been adopted on the Mahanuddee and Cossye rivers. The shutters were hinged to a horizontal axis on the floor of the sluice in two rows placed back to back. The upper ones folded up stream, and the lower ones folded down stream. The back or down-stream shutters were about 18 in. higher than the front row. When the movable dam was open and the water flowing over it, the front or up-stream shutters were held by hooks to the floor, so that they could not rise. To close the sluices the hooks were released by a bar, which could be manipulated from the pier; the shutters were at the same time slightly lifted by the same bar, and when the stream got under them they were forced upright. Chains, which were attached to the front of the shutters, received the severe blow which was brought on them by the sudden raising of the shutters. The back shutters, as soon as the front ones had been lifted, were raised by hand from the back, and were retained in position by wrought iron struts behind them. When all the back shutters were up, the lower ones were pushed down on to the floor and fastened with the hooks, and the movable dam was then ready to be opened at any moment. To open the movable dam, the struts of the back shutters were released from the cast-iron shoes in which they rested, by the action of a horizontal bar which lay on the floor. This bar caught the struts one after another, as it was moved by gearing on the pier, and released them; the shutter then fell and the waterway of the sluice was opened.

On the Sone weir the movable part was in three lengths—one at each end and one at the center of the weir. Each length consisted of twenty-two shutters, 20 ft. 7 in. long by 9 ft. 9 in. high. There were two shutters, the front and the back one, between stone piers; the front shutter was hinged horizontally at its heel to the floor. It folded forward—or up stream—into a nearly horizontal po-ition on the floor. Each shutter had on its down-stream side six hydraulic brakes. These impeded the closing of the shutter, and prevented the shock which was so objectionable in the form of movable dam previously described. The brakes were simply formed of a pipe which was hinged to the shutter, and a strut hinged to the floor, the head of which was fitted with hydraulic packing. When the front shutter was lying horizontally the pipe became full of water from the river. In the pipe were three holes, $\frac{7}{16}$ in. diameter, through which the water was expelled as the shutter rose. The back shutter was hinged by tension rods on its up-stream face. The rods were hinged at one end to the shutters a few inches below the center of pressure of the water on the shutter when erect, the other extremities of the rods were hinged in the floor between the two shutters. The shutters, when the water was level with their crests, were on the point of overturning, as they were hinged slightly below their center of pressure. When the water rose a little above their crests, they did overturn. Chains to prevent them doing so were fitted with let-go gear. As a rule, the back shutters were kept up to retain the water, the front ones being fastened down on the floor. If a flood was expected, the chains of the back shutters were let go, and when the river had risen to a certain height, they opened of their own accord. To close the movable dam, the front shutters were one by one slightly raised by hooks worked by levers from the piers. The stream then impinged below the shutters, and forced them up into the vertical position. The hydraulic brakes decreased the velocity with which the shutter would ascend, and relieved the piers and masonry from shock. When the front shutters had been raised, the back ones were pulled up by hand, and the front ones were put back into their horizontal po-ition on the floor. Some improvements in this form of weir were suggested. As the action of the movable dams of the Sone weir had not been found sufficiently powerful to keep a channel clear for navigation, a row of shutters, sim lar in principle to the back shutters, but only 2 ft. 3 in. high, was to be placed all along the crest of the weirs, which were 2½ miles long. The paper described briefly a system of double-tumbler shutters, which had been proposed by Mr Fouracres, who introduced the system of the Sone weir, but which had not been as yet adopted in practice.

APPLIED SCIENCE EXHIBITION, PARIS.

SANITARY APPLIANCES.

M. A. DUMUIS, Paris, demonstrated, by the aid of glass models, the efficacy of Mr. Banner's ventilating cowl, and also showed several sizes of his own manufacture, many applications of which he has already made in Paris. Jewell's system of ventilating a house was shown by an elaborate model.

Messrs. J. L. Bacon & Co., London, showed in action their method of warming buildings by coils of small wrought-iron pipes, and also drawings of a drying and disinfecting closet on the same system, in which a temperature of 500° Fahr. may be obtained.

The Compagnie Générale de Filtrage, Paris, had on view a large assortment of their filters, which consist of a cast-iron case, made in the form of an inverted truncated cone, in order that, when the filtering substances become charged with impurities, they may, by preventing the flow of water, give warning of the necessity for renewal. The substances employed for filtering are—sponge, crushed sandstone, wool, animal charcoal, and sand or gravel, the order of which is slightly varied for different waters.

It is forbidden in Paris to discharge night soil into the sewers; it is, as a rule, received into cesspools. But the cost of emptying these has led to a new system being adopted, especially where w.c.'s are used. The soil is received in *tinettes*, or cylindrical receptacles, with a perforated diaphragm, which allows the liquid to run off into the sewers (under special license), while the solid matters remain behind in the *tinettes*, which are replaced periodically. Still the cost of emptying is heavy; and a company has been formed in Paris for doing this work gratuitously for the sake of the manure, provided the houses be fitted, at a fixed scale of charges, with their arrangement of *tinettes*. In this arrangement, the liquid is intercepted by two separate enlargements of the soil pipe, and allowed to flow into the sewer without having to filter through the soil in the *tinette*. Closets on this system were fitted up in the Exhibition for the convenience of visitors, and those interested could make themselves acquainted with the working. M. Gérault showed his simple siphon w.c., to be flushed with water, which has no mechanism but the conical valve for admitting the water, with chain and bell crank.

The St. Luc inodorous disinfectant is stated, in an analysis made at the laboratory of the Museum of Natural History, Paris, to have the power of absorbing and fixing 266½ liters (9½ cubic feet) of ammoniacal gas, or 136½ liters (5 cubic feet) of hydrosulphate of ammonia. It is used by the Paris municipality and in the leading hospitals. M. A. Schlumberger showed several applications of salicylic acid, which has been called "the most rational of antiseptics." In hospitals it is recommended as a disinfectant, especially when combined with 25 parts each of alcohol and glycerine and 50 of water. Fumigations made by vaporizing a small quantity on a red-hot shovel have the advantage of giving no disagreeable odor. This substance has also been applied with great success to the preservation of all kinds of food; and M. Schlumberger has some specimens of vegetables prepared in May, 1876, for the Brussels Exhibition, which, though their receptacle was opened twenty times a day during that period for showing to visitors, are still in a perfect state of preservation. Some Normandy butter, mixed with a thousandth part of salicylic acid, has been sent out to Brazil and back, when it was found to have retained its flavor and freshness. M. J. A. Pennès, Paris, exhibited a case of uncooked fish, meat, etc., preserved by his antiseptic, which consists of salicylic acid associated with alumina, benzoin, and a preparation of the eucalyptus. This substance is admirably suited to the preparation of anatomical and zoological specimens, because it has the property of hardening without altering the tissues.

APPLIANCES CONNECTED WITH THE NURSERY.

The diploma of honor in the *Classe de l'Enfance* was awarded to the Société des Crèches, who exhibited an elaborate model, showing the interior economy of their establishments. A model was also sent of the English Orphanage at Neuilly, in the foundation of which Messrs. Galignani were chiefly instrumental.

Views accompanied by a description were shown of the Ferme d'Arcy, about thirty miles from Paris, on the Eastern line, where over a hundred cows are kept for supplying the metropolis with milk absolutely pure, and from the same cow if required. The morning's milk is cooled in a refrigerator, and kept at a temperature of 4° Cent. (39° Fahr.) until eight P.M., when it is mixed with the evening's milk, and put into small white, earthenware jars, with air-tight covers, sealed with lead, containing the supply ordered by each customer. These leave at ten o'clock and arrive in Paris at midnight, when they are kept in refrigerators until delivery at five o'clock the following morning. The milk of the Domaine de Courquetaine, in Seine-et-Marne, is somewhat similarly treated, but is packed in jars of tinned iron, with locked air tight covers. Dr. Liebaut exhibited his *hochet*, or child's coral and bells, having, on the end inserted in the mouth, a hollow and perforated India-rubber capsule for inclosing pastilles, compounded with various medicaments, sugar and gum.

There were two appliances for supporting children while learning to walk. One, by Mr. Lavergne, Paris, consists of a padded hoop, to be fastened round the waist, supported on four splayed-out legs, capable of being lengthened or shortened, and running on casters. The other, shown by M. J. Mégissier, Place Dumesnil, Paris, consists of a table on wheels, to which the child is strapped, but having a seat brought up automatically directly he stoops to sit, and removed on his again standing up. Some perambulators were shown, the frame and wheels of which pack into the body, forming a parcel that can be carried under the arm. On the opening day the late M. Jules Favre gave the name of *cheval hygiénique* to a new rocking horse, devised by Mr. Meinhard, engineer, London, which affords more exercise and a nearer imitation of the action of riding than its predecessors. The "horse" is articulated by two uprights, about 6 inches apart, to the fixed stand, while strong spiral steel springs, at the front and back, are alternately compressed and drawn out by the weight of the child's body, thrown alternately forward and backward.

DOMESTIC.

A piece of "cork leather," made by Messrs. De Beerski & Co., London and Paris, was laid down in front of their stand, in the nave, where it was walked upon by the thousands who visited the Exhibition during the four months it remained open; and yet, though not fixed down as usual, and subject to the sand and gravel with which the nave was laid being carried on to it by the feet, it showed no sign of wear at the close. It consists of cork, in a finely divided state, attached by India-rubber solution to a flax cloth, and, owing to its non-conductibility, forms a very comfortable carpet. The "cork cloth," consisting of a thin sheet of cork between two tissues, has been much improved since the Maritime Exhibition in 1875, and is used in the English and French navies, and the English army, for waterproof garments, sheets, tents, etc, being impenetrable by fresh or salt water and the sun's rays, and not attacked by insects, while it is also very light and supple. M. Bourguignon, Donchéry, Ardennes, makes from the feathers of poultry, which would otherwise be wasted, a felt which is lighter and warmer than woolen fabric. It is of different thicknesses and various colors, so that it can be made up into garments for both men and women. M. Martin showed some muslin curtains rendered fireproof, to which a flame was constantly applied, with the effect of charring them only. M. Nomita, of Paris, exhibited clocks and watches provided with dials which appear luminous in the dark, so that the hour can always be ascertained.

M. J. Sprunk, Paris, showed some improved meat-mincing machines, for hand or power, in which two horizontal shafts, armed with curved knives, revolve in contrary directions, the knives just clearing one another, while the concave basin turns on a vertical axis. Wladislas Kleczkowski, of Vilna, offered to visitors his concentrated *bouillon*, which he recommends in preference to extract of meat, because containing all the component parts of ordinary *bouillon*, including the fibrine and albumen. M. Bessède, *hors concours* as a member of the jury, showed his preparations from the eucalyptus, for superseding injurious liqueurs, such as *absinthe*.

MISCELLANEOUS.

A diploma of honor was awarded to the Count de Beaufort, on behalf of the Société de l'Assistance aux Mutilés Pauvres, for the mechanical limbs exhibited. A carpenter working at his trade, and a girl knitting, both supplied with artificial arms, were to be seen daily at the Exhibition. A similar honor was accorded to Dr. Gustave Zander, of Stockholm, for his mechanical appliances for medical gymnastics, whereby the frames and muscles of weak and sickly persons are strengthened, and various ailments and deformities treated. M. Paz, Paris, showed a full-sized gymnasium with the latest improvements, and also working models of chamber gymnastic appliances for curing defects. Messrs. J. R. Whitley & Co., London and Paris, showed the "Gwynfé" patent hammock tent, which affords a portable weather-proof shelter and sleeping place, quite independent of ropes, trees, or pegs, and folding up into very small compass. M. J. Lézard contributed his appliance for permitting a man to exist while surrounded by deleterious gases. A mask, tightly fitting the head, is put in communication with a pure air supply by a flexible tube, thus permitting the wearer to breathe both through the mouth and nose.

M. Richard, Paris, an army clothier, finding that the use of the sewing machine exercised an injurious effect on the health of his workwomen, and estimating that the cost of any known motor would swallow up too large a proportion of the small profits of his business, devised an appliance, in which an ordinary French poodle, held in a cage outside the center of gravity, by stepping continually on the outside of a drum, develops sufficient power to drive four sewing machines. In this *moteur-quadrupède*, which is applicable to all vertebrate animals, the dead weight is turned to full account, scarcely any muscular force is exerted, and there is no liability to accident or discomfort. M. Engström showed a bit and bridle for controlling unmanageable horses by means of an interrupted galvanic current, and also a manger, on the same principle, for curing horses of crib biting. M. Babonneau showed a new bit, used by the Cie. Générale d'Omnibus, for more effectually controlling horses, without bearing on the lower jaw or giving them pain. The bit itself is a tube, merely serving as a fulcrum for the two levers on each side, which, on being pulled by the reins, draw the muserole on to the nose, thus giving complete command over the animal, while his taking the bit between the teeth would not prevent its action.

Signor Danielli, who coated by electro-metallurgy the plaster cast in the 1878 Exhibition of the equestrian statue of the Prince of Wales at Bombay, exhibited some wonderful reproductions of ancient statues, etc., made of hardened plaster of Paris, coated by electro-deposit. M. David, Paris, showed specimens of his universal stencil plate, or sheet of thin metal perforated with fine elongated holes, arranged in such a pattern that all letters of the alphabet, with stops and accents, the Greek capitals, and a great variety of ornamental borders, can be traced out by it. Two modifications of the electric pen were shown; one, worked by a galvanic battery, and another driven by compressed air acting on valves, which, by gear, communicate the reciprocating motion to the needle. M. Ruentz showed a simple little instrument for describing ellipses with the aid of an ordinary set-square. M. Delagarde manufactured, in the presence of visitors, his paper binders, which consist of two strips of metal, curved transversely, so as to approach each other, hinged together and kept closed by two clasps.

RING-SPINNING IMPROVEMENTS.

MR. TATHAM, of Rochdale, is the author of several improvements in connection with ring-and-traveler frames, the most recent of which is a method of forming the cop, either upon the base spindle or in conjunction with paper or other tubes, its object being to make a perfectly firm cop. This is accomplished by imparting to the copping-rail an upward or downward motion, varying in mechanical arrangement or speed from that which is commonly used, or in addition to the latter. This varying or additional motion is employed for causing successive lappings to be bound together.

The means employed for the purpose is illustrated in Fig. 1, which represents a cross section of a ring-and-traveler frame having Mr. Tatham's new mechanism added to it, and in Fig. 2, which is a partial view of the same.

1 is the ring-rail, and 2 the bolster-rail; the first of these carries the rings, 3, and is connected to the usual poker-bars. 4 is a shaft, on which is a roller, 5, one end of the chain, 6, being attached thereto, and the other end being connected to a bracket, 7, extending from the poker-bars. When, therefore, the shaft, 4, is turned, the ring-rail, 1, may be raised and afterwards allowed to fall by its own gravity, to effect which there is a hand lever, 8, on the shaft, 4, which lever carries a click, 9, that takes into the teeth of a ratchet wheel, 10, mounted on the shaft, 4.

Now, supposing the spinning to be going on for the formation of a cop in any known manner upon the bare spindle, or upon a paper or other such tube placed on it, the coils of the yarn will be wound in successive spiral rings, which are comparatively loose, there being no means of binding them together. But if, during the ordinary winding, the hand lever, 8, be moved upward, the click, 9, will drive the ratchet wheel, 10, and consequently the shaft, 4, and the chain, 6, will be coiled upon its boss, so as to draw upward the poker-bar and elevate the ring-rail, 1; and if this elevation be effected at a quicker rate than that necessary for ordinary winding, it is evident that the thread will be caused to bind the coils already wound, so that the whole becomes bound as it were together. This operation may take place at any required interval during the formation of a cop, and may either extend throughout its entire length, or may be confined to any particular part of the same where it is most desirable to bind the threads together. The above effects have been described as due to raising the hand lever, 8; but of course the same effect may be accomplished by turning it downward (after it has been raised), so as to allow the rail, 1, to descend faster than it would do for the ordinary operation of winding.

Thus far we have described how the object of the present invention may be carried out by hand, and we now proceed to explain how the same may be automatically performed.

Upon the shaft, 11, of one of the tin drums is a toothed pinion 13, taking into a wheel, 13, which drives another wheel, 14, on the axis, 15, of which last is a bevel, 16, in gear with another, 17, mounted on a shaft, 18, the lower end of which shaft is provided with a worm, 20, taking into a wheel, 21, the shaft, 23, of which carries a cam, 22. This cam is thus caused to revolve in the direction of the arrow, and its surface from *a* to *b* represents the lift of the rail, and from *a* to *c* the drop.

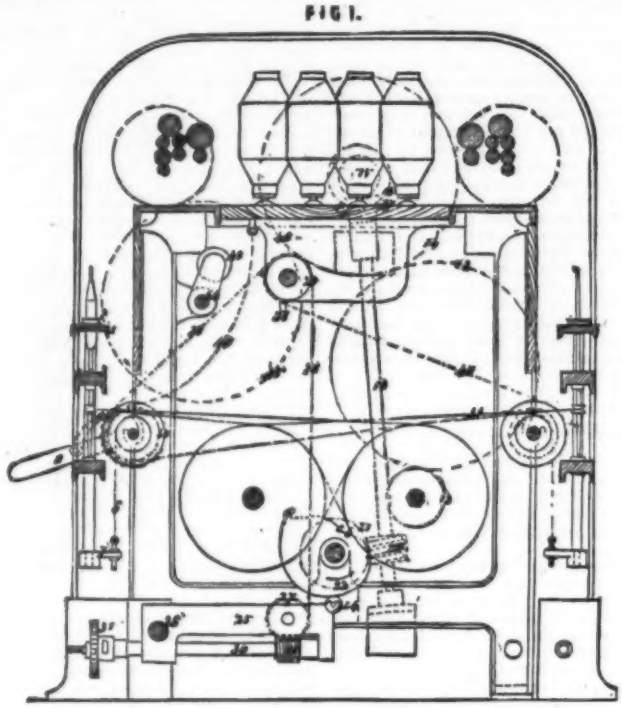
In contact with the cam, 22, is a bowl, 24, mounted in a lever, 25, which turns upon a center, 26, and carries, by means of a pulley, 27, one end of a chain, 28, which, after passing over a pulley, 29, is attached at its other end to a pulley, 30, carried by the shaft, 4, above referred to.

According to the positions shown in the figure, the ring-rail is partly lifted, by means of the cam, 22, by the part between the points, *a* and *b*, on the bowl, 24, the lever, 25, having been caused to turn downward on its center, 26, so as to draw the chain, 28, and cause the shaft to revolve, thereby drawing up the chain, 6, as above described. A further revolution of this cam, 22, continues thus to elevate the ring-rail until the whole of the lift has been accomplished, the bowl, 24, being then at the point, *a*, and it is then that the essential feature of the new mechanism comes into operation.

The cam continuing to revolve presents a radius to the bowl, and the ring-rail begins to drop, and continues to do so until the point, *c*, is reached; but, instead of doing so at the same rate at which it was lifted, it descends more rapidly than it rose; and it will be seen that for this reason the vibration of the lever against a click, 32, mounted on a loose arm, 33, which comes against a fixed stop, 34, thereby turning the shaft, 30, a portion of a revolution, and through the medium of a worm, 35, partially turning the pulley, 27, to which the chain, 28, is made fast. Upon the pulley, 29, is a finger, 36, which at the commencement of making a cop is in contact with the chain, 28, so as to press it outward and take up part of the chain; but in the position shown in the figure, the base of the cop has been formed.

Supposing now that the base is being formed, the lowering of the ring-rail will, by turning the pulley, 29, press this finger against the chain, so as to neutralize a portion of the lowering effect, but, as at each traverse a portion of the chain is taken up by the worm, 35, the lowering gradually decreases with the building of the cop bottom. During this operation the finger, 36, is gradually being turned away

FIG 1.



RING-SPINNING IMPROVEMENTS.

coils of yarn, instead of being wound side by side as usual, are caused to overlap at an angle those previously deposited, so as to bind the whole together, thus producing an unusually firm cop. By inspecting the form of the cam, 22, it will be seen that it does not, on the dropping side go down gradually to the lowest point; it might do so, but the variations are simply for the purpose of regulating the form of the cop, an arrangement which is well known in ordinary spinning; but it will be seen that the present arrangements depend upon an independent principle, viz., that of varying the relative speeds of the rising and falling of the ring-rail, and it will be obvious that, by reversing these relative speeds the lifting of the rail may be quicker, the same effect being accomplished. It will also be evident that, by altering the shape of the cam, 22, the angular laying of the threads may be varied, so as to be more or less at any desired part of the cop. It should also be observed that while the operation is going on automatically, if the lever, 8, be operated by hand, the crossing may be regulated as it may seem desirable.

We shall now describe how the formation of the base of the cop may be effected in conjunction with the new mechanism.

Upon the lever, 25, is mounted a shaft, 30, carrying at its outward end a ratchet wheel, 31, which is carried by the from the chain, and when the cop bottom has been formed will fail to reach it, after which the successive lifts are governed by the worm, 35, only, until the cop is completed. Similar motions to those above described are imparted to the parts on the other side of the frame by the chains, 40 and 41.

These arrangements for the building of the cop may be varied according to any well-known means. The means adopted for causing the layers of yarn to be laid at angles, as above described, may be supplemented while the base of the cop is being made in the following manner:

At 43 is a tappet mounted on a shaft, 44, which is driven from the wheel, 14, through the medium of another wheel, 45, and at 46 is a chain attached at one end to a stationary part at 46, and at the other to a pulley on the axis, 4. At the commencement of the base of the cop the chain, 46, is within range of the tappet, 43, which, by acting upon it, turns the shaft, 4, so as to produce an extra angle just as may be produced by the hand lever, 8, as above described; but when the base has been formed, the tightening of the chain, 28, will have loosened the chain, 46, so as to cause it to hang down beyond the range of the tappet, 43.

Another improvement that has been introduced by Mr. Tatham consists in a method of doffing the full cops and commencing fresh ones. When the cops are ready for doffing, the copping rail being near the tops of the spindles, the cops are lifted a little way up, leaving the parts of the spindles bare where the building of the cops is commenced, and then the gum brush is run on the spindles, or split tubes are put on. The copping rail is then lowered to that part of the spindles where the building of the cop commences, and a few coils of yarn which form part of the cops are wound. The full cops are then removed, by which means the threads are severed, and the frame is ready for work again.

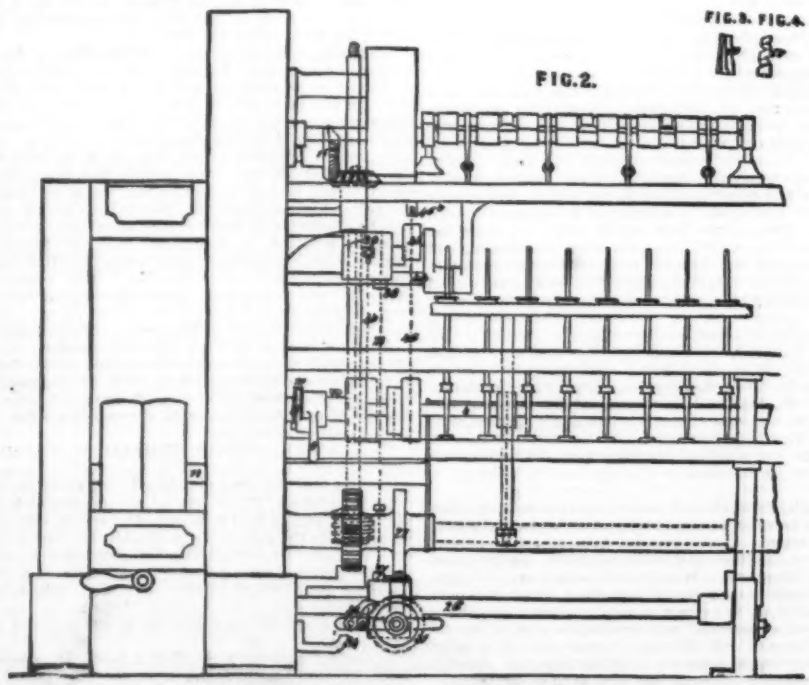
A third improvement consists in a method of forming and adapting paper or other such tubes as are used in spinning frames to form a support for the spun or doubled material. To facilitate the adaptation of these tubes, they are formed with a longitudinal slit, straight or curved, by means of which they may be adapted to the spindles without passing them over the tops of the latter. By this means the building of the cop may be commenced at once upon the tube with yarn that forms a part of the cop, and therefore without the waste which now takes place by winding below the tubes. These slits are widened at the bottom to increase the facility of adaptation.

Fig. 3 represents a tube of paper constructed on this plan, having a longitudinal slit, 50, formed in it, and, by being pressed against the face of the spindle, it is readily fixed in any required position.

Fig. 4 represents another construction. In this case the slit is of a spiral form. The tubes may be secured on the spindles by screwing them on from the end of the spiral.—*Universal Engineer.*

FIG.3. FIG.4.

FIG.2.



RING-SPINNING IMPROVEMENTS.

ESTIMATION OF THE TOTAL CARBON IN IRON AND STEEL EN MASSE.

By Sydney C. Jutsum.

The author, having had some experience in these analyses of their inherent difficulties and the best means of overcoming them, takes the present opportunity of laying them before the readers of the *Chemical News*, trusting they will prove of service to those who perform iron and steel analyses.

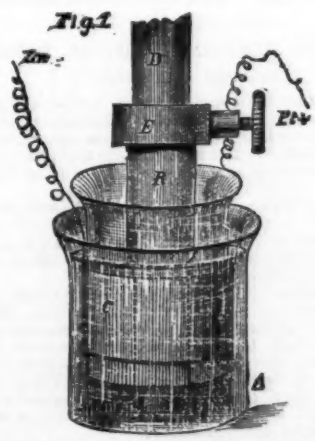
There are three principal methods employed for this purpose: 1st. Regnault's, or the direct combustion of the iron. 2d. Berzelius', or dissolving by means of $CuCl_2$ and subsequent oxidation of the separated C. 3d. Weyl's, or the electrolytic solution of the metal and subsequent oxidation, as in No. 2. (*Pogg. Annal.*, 114, 507.)

1st. *Solution of the Metal.*—One is met at the outset by the following difficulties: Method No. 1 requires "the iron to be in the finest powder, and passed through a plate sieve with very small holes." (Fresenius, "Quant. Anal.") Now there are many samples of metal which it is impossible even to file, and can only be cleaned by the grindstone; and the softer specimens are very liable to become mixed with foreign bodies when being pulverized and sieved.

No. 2 method effects solution by means of the following mixture: 6 oz. $CuSO_4$, 4 oz. NaCl, 2 fl. oz. HCl, and 20 oz. water. In Fresenius' laboratory I saw NH_4Cl employed instead of NaCl. Both at King's College and Fresenius' laboratories I have seen four to six days required to dissolve 10 grammes of *soft iron turnings*. With the tool steel which I used for analysis this method was also inapplicable, because the metal was too hard even to file, and such a compact block of metal would have required weeks—perhaps months—for solution. I therefore pointed out the two objections to these two methods, viz.: 1st, the impossibility of reducing the metal to "turnings" or chips, much less fine powder in many cases, and the danger to its purity even when attained; and, 2d, the length of time required for solution. But I never received any satisfactory reply to these two main objections. In addition to the above objections, I may add the employment of free acid, as in the above solution, is dangerous, as it causes a loss of C in the form of gaseous hydrocarbons, more especially if the mixture is heated. (*Hahn. Annal. d. Chemie u. Pharm.*, 129, 76.) Without free acid the time is longer. Again, the precipitation of the metallic Cu is a drawback, causing waste of H_2SO_4 and CrO_3 in the subsequent part of the analysis (should Ullgren's method be employed to oxidize the C), or else an extra loss of time to effect its solution.

With the 3d, or electrolytic method, none of these difficulties arise. 1st. There is no need to pulvervize the metal; and, 2d, the time is about one hour to effect solution of 10 to 15 grammes metal. I used to start it to work the last thing before leaving off work, which requires about one hour; it proceeds during the night by itself, and on arriving next morning one finds 10 to 15 grammes of the hardest tool steel dissolved, and the C separated out in large flakes, and in an excellent condition for filtration. There are, however, a few simple precautions to be observed; this done, the method works rapidly and accurately. A single Grove or Bunsen cell is employed, and a simple decomposing cell, which I found to answer very well, as represented in Fig. 1.

Fig. 1



A is a beaker of about 5 oz. capacity, containing HCl, in which is immersed a glass cylinder, B (a beaker without a bottom), and *between* them is a Pt foil connected with the negative electrode. The best strength for the HCl is sp. gr. 1,050, or about 1 pt. HCl *conc* and 3 water. Fresenius merely says "dilute" acid; but I found sp. gr. 1,100, or 1 pt.

HCl *conc.* to 1 water, to be too strong, causing Cl to be evolved at the surface of the steel, and thus running a risk of loss of C. D is the steel bar, and E a common binding screw. The object of this cell is to see if any bubbles of Cl or gaseous hydrocarbons are given off at the surface of the steel, which would prove fatal to the success of the analysis, and which in an ordinary decomposing cell is not at all easy to ascertain on account of the violent evolution of H from the negative electrode. The steel bar is best preserved from rusting by a strip of rubber sheeting tied round it, leaving 1 inch exposed for solution, R, Fig. 1. Next comes the binding screw, E, for the purpose of connecting it with the battery, and the rest of the bar may be protected by a thermometer case from the acid fumes. By these means I was enabled to preserve its brightness for two weeks. The bar I employed was 11 inches long by ¼ inch square. It was first *ground* bright, weighed, and immersed in the cell to a depth of about 1 inch. After solution it was again weighed; the loss represented the steel dissolved. With regard to the strength of the current, two quart Daniell cells are too weak to overcome the resistance due to the liquid and counter current, and two Groves or Bunsens are too strong, causing the evolution of gas at the surface of the steel. It is important to regulate these various factors, as otherwise the solution proceeds too slowly, and, on arriving next morning, the steel is not dissolved; or it proceeds too rapidly, and then ensues a loss of C. As before stated, one hour's work the last thing before leaving is all the time required to effect solution by this method when properly conducted, and the process proceeds and finishes by itself during the night.

3d. *Filtration of the* C.—Of course filtering paper is inadmissible. It is recommended in the text-books to use an asbestos filter tube, but it is difficult to make it work satisfactorily. The C is often in very fine powder, especially when the method No. 2 is employed, and the filter is very liable to allow the C to run through or to choke. I tried pounded glass, glass wool, but with much the same effect, and have seen in the laboratories the results obtained by others. I have seen hours taken to filter and wash the C even when using a water pump. I have therefore invented a simple apparatus, which, while it does not permit the finest particles of C to run through, at the same time allows the whole operation of filtering the contents of the decomposing cell, washing with soda, and, lastly, with water, to be completed in 10 or 15 minutes. Fig. 2 represents the apparatus. A is a glass tube, about 12 inches long, 1 inch wide, and ¼ inch thick in the walls. Half an inch from one end is filed a groove, E. The tube is inserted in a doubly-perforated stopper, B; the other perforation contains a tube connected with an exhausting pump, C. The stopper is inserted in a *thick* glass bottle, D. Over the end, E, of A is first placed a disk of *filtering paper* (the purpose of which will be explained further on) next a piece of *muslin*, and, lastly, a piece of wire gauze, the whole being securely wired on to the tube, the groove, E, preventing it slipping off. Into the tube, A, purified silver sand is next placed to a height of 1 inch, and upon that glass wool to the same height. On pouring the contents of the decomposing cell into the tube, A, and exhausting, the entire contents were completely filtered and washed in ten minutes. It is important to wash first with water, then with caustic soda, and, lastly, with water, in order to insure the complete removal of HCl, which, if allowed to remain, would give rise to Cl in the Ullgren's apparatus and increase the weight of the potash bulbs. The stopper, B, is then removed, the cap is then taken off the tube, and the contents are pushed into the flask of the Ullgren's apparatus by first inserting an extra plug of glass wool and pushing it down into the tube; the entire contents are thus completely removed. On examining the little disk of filtering paper no C is ever seen on it except a minute *brown* stain. This filter tube when carefully managed never allows the smallest particle of C to run through and never filters slowly, the liquid running out so rapidly as to even cause some little trouble to keep the tube full.

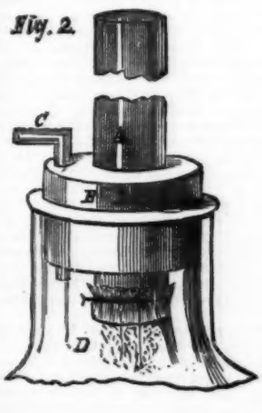


Fig. 2.

3d. *Oxidation of the* C.—This can be easily done either in a combustion furnace or in the well-known Ullgren's apparatus with H_2SO_4 and CrO_3. I met with an unexpected difficulty, owing to the KHO containing potassic nitrite, which, by absorbing the O, increased the weight of the potash bulbs too much. Mr. G. S. Johnson was the first to point out this reason to me, as he had previously found the same impurity in caustic potash, and his results I confirmed by a long series of experiments, which, however, are not considered interesting enough for republication. Another source of error is the difficulty of obtaining a constant figure on removing, weighing, and reattaching the potash bulbs to the apparatus. The difference, however, is small, and the general opinion seems to be that the CO_2 is absorbed into the interstices of the pumice, and is with difficulty dislodged.

In conclusion, I have to thank Prof. Bloxam for his great kindness in correcting this MS. and for superintending these analyses, and to Prof. W. N. Hartley for kindly giving me the benefit of his experience in iron and steel analyses.

THE WESTERN MINING REGIONS.

PROFESSOR W. P. BLAKE lately addressed the Bullion Club, New York city, on the subject of his recent trip among the Western Mines.

He spoke of the great quantity of snow which covered the great ranges of mountains, on some of which it was deeper than ever before known. This winter, he said, has been unexceptionally severe on the ranges. The great fall of snow, however, promises an unusual harvest of gold next season, for it is with the water coming from this snow that the placer miner secures the gold.

In describing his trip from Salt Lake City he said that he first came to the Bingham Cañon deposits, which have excited more than usual attention and interest during the past summer. They are great ferruginous outcrops, carrying deposits of argentiferous lead and bodies of carbonate lead, also great masses of iron pyrites. The miners paid little regard to these deposits until last season, when they found that the larger portions of the outcrop paid for working in the ordinary way. The absence of a bountiful supply of water has, however, been disadvantageous, and it is proposed to transport these ores to Jordan River to have them refined.

In the district in which the noted Ontario Mine is located, mining has been carried on very successfully during the past year. In the Ontario Mine a depth of six hundred feet has been reached, and the vein looks as well below as above. One prominent feature in regard to the increasing value of this property is its consolidation with the Last Chance Mine, which adjoins it. This consolidation will greatly strengthen the Ontario in regard to the producing of ore, as explorations in the Last Chance have shown great richness. The lodes extending beyond these mines seem to contain mineral for several miles.

In southern Utah there are many interesting properties. The great Silver Reef region is of particular interest to miners, from the fact that it is a vast mass of ore in modern sandstone, in which very few miners would ever look for valuable deposits of silver ore. The completion of the Utah Southern Railroad has opened up many interesting districts which have heretofore been inaccessible. The town of Butte is a particularly interesting mining center for Montana, as some of her best developed miners are located there. The principal mine of that region is the Alice, which is now down to a depth of five hundred feet. The vein is from forty to eighty feet in width, and passes through different bodies of ore which might be called low grade.

In Nevada there are the important mines of Eureka and Comstock. The hot water of the latter, he thought, was local, and if it should be caught and carried off, the heat would be much lessened. To secure the future success of the Comstock, there should be consolidation and unity of interest, and a deep shaft should be started far east to intercept the vein at a considerable depth.

Bodie, which belongs to the interior system of mineral deposits, is one the most interesting mineral deposits of which there is any knowledge. In California the gold mines, wherever worked with skill and energy, are doing remarkably well. Just now there is a period of depression in that state. The empire is now paying dividends. It is an enormous vein and a promising mine.

Plumas county, one of the best gold-producing counties in the state, contains the Green Mountain, Cherokee, Gold Stripe, Plumas, National, Crescent, and others. The Crescent has been worked with great profit for a long time, and has declared $300,000 in dividends. The Green Mountain Mine has the advantage of being upon a mountain, and can be worked by tunnels rather than by shafts. This location is such that the ores can be excavated and trammed out to the mill at a smaller expense than probably any other mine at the present time. The ore from this mine yields from $7 to $10 per ton, which leaves a very large profit. The vein is very large, and has some peculiar characteristics which mark it as allied to deposits of hot water.

The Indian valley has a great history, but is lying idle and awaiting enterprise and capital to reopen it. The Gold Stripe is now being worked successfully, and promises well for the future. All the mines in this group in the vicinity of the Indian Valley are well supplied with timber and water, and everything necessary for successful mining operations, and, it is hoped, will add largely to the bullion production of California.

In Arizona great interest is manifested in mining. This will be one of the greatest mineral producing territories, and it will be especially interesting because it is soon to be opened throughout by the Southern Pacific Railway. The climate in that country is never so severe as to interfere with mining operations, and railroads are soon to be built, making the mining regions accessible from the east and west. The San Juan region is in Southern Colorado, and contains some of the highest mountains in the Rocky Mountain system. There are mountains with silver-bearing veins from the summit to the base, and this district is destined to be one of the most important mining centers of the American continent. Water and timber are abundant, and on the western slope the climate is remarkable; the soil is fertile in many places, and there are vast beds of coal nearly equal to those of the great coal fields. Further to the north and east of this region is Leadville, which is the most remarkable mineral locality in the known world. In conclusion, he said: "Taking the immense amount of bullion produced from the mines in our country, we can say that mining has become a great industry, and each one of us should put his shoulder to the wheel and endeavor to push it ahead."

ON ACTINOMETERS.*

DURING my study of the chemical action of light in its application to various photographic processes I have had occasion during the last ten or fifteen years to try many of the numerous forms of photometers. Feeling the great importance of the subject, and also the growing interest recently evinced, I hope the following remarks may not be deemed unsuitable.

The simplest and also most useful photometer is based on the fact that a chemical change is produced in salts of silver by light, with a resulting change in color. For special purposes chromium salts are used in a similar manner.

The action of light can also cause chemical combination, and on this principle is based the chlor-hydrogen photometer, proposed by Dr. Draper, and also by Bunsen and Roscoe. On the principle of chemical decomposition numerous actinometers are based, and many substances were employed for this purpose, such as peroxalate of iron, by Dr. Draper; nitrate of uranium and oxalic acid, by Niepce de St. Victor; bichloride of mercury with oxalate of ammonia, by Becquerel; perchloride of iron with oxalic acid, by Marchand; perchloride of iron with nitro-prussiate of soda, by M. Rousin; peroxalate of iron with chloride of gold, by Dr. Draper; and, lastly, Dr. Monckhoven introduced an actinometer almost similar to that of M. Niepce de St. Victor.

Many more substances than the above can be used for measuring the action of light, based on the chemical decomposition produced by light, whilst other photometers are based on the measurement of the electrical current accompanying the chemical action produced by light.

Chloride of Silver, or Chromic Salts, Paper Actinometers.—These are the simplest, and almost exclusively used by carbon printers and for all processes where the action of light cannot be seen till after some subsequent operation. I do not intend to give either detailed descriptions of the numerous varieties of this useful instrument nor yet their pedigree. I merely intend to describe a few or the less known and recently introduced varieties.

The general principle on which these are based is the operation of the law that sensitive paper exposed to the action of actinic light changes color, and that the intensity of color is in direct proportion to the intensity and duration of exposure to light. Sensitive paper discolored by the action of light is compared with a permanent tint, approaching in color that assumed by the sensitive paper. But here comes the first difficulty. The sensitive paper does not assume the same color invariably. The very same sheet sometimes assumes a blue tone, whilst at others it takes a brown hue. This is dependent on the quantity of moisture and ozone present, and on the temperature of the atmosphere.

To avoid this inconvenience, and to produce as far as possible uniform results, several formulæ were proposed for the preparation of sensitive papers for actinometers. Professors Bunsen and Roscoe, after laborious researches, established the following rules for the preparation of standard papers of uniform sensitiveness: Saxe or Rives paper (thickness of the paper has no material influence) is uniformly soaked with a three per cent. solution of sodium chloride. The sensitizing bath of silver nitrate must not be suffered to drop below six per cent., and the sensitizing must not be of less duration than fifteen seconds. Such paper will keep at least fifteen hours unaltered.

Dr. Van Monckhoven recommends the following: The paper used is Saxe or Rives, without further preparation. It is soaked for two minutes in—

Sodium chloride	100 grammes.
Distilled water	2 liters.

It is dried, and afterwards sensitized in the dark by immersion in—

Silver nitrate	100 grammes.
Distilled water	2 liters.

Ten sheets of paper are immersed one after the other, and, after removal, washed in fresh water and dried. This paper remains white for a very considerable period; but it was found by its author to be insensitive, and in order to increase its sensitiveness is is recommended that a lump of carbonate of ammonia wrapped in *papier Joseph* be kept in the photometer. If this lump be bigger than a nut the paper will turn yellow. M. Lamy's formula is the following: The paper to be used is Rives (8 kilog). It is immersed for ten minutes in—

Ammonium chloride	2 grammes.
Water	100 c.c.

When dry, it is floated on the surface of—

Distilled water	100 c.c.,
Silver nitrate	12 grammes,
Citric acid	6 "

for four minutes. This paper is sensitive, and can be preserved several months. M. Vidal, and the great majority of carbon printers, use ordinary ready sensitized albumenized paper.

It is generally remarked that we can much more easily discern the difference in pale tints than in the dark ones, and this property is taken into consideration by all inventors of photometers, although different means to solve any difficulty arising therefrom are introduced.

The Autotype Actinometer.—The simplest of all has a single tint for comparison. When sensitive paper reaches this tint a fresh portion is substituted, and by this means two, three, or any number of tints can be obtained, according to the necessity. This form requires constant watching, and any error of observation is repeated.

Monckhoven's Actinometer has also a single tint for comparison, and is to a large extent similar to the autotype. To avoid the necessity of making several exposures the light acting on the sensitive paper is admitted through ground glass, and an aperture, the size of which latter is regulated in such a manner as to have always the same tint, equivalent to the required amount of light.

Dr. Vogel's, Burton's, Leon Vidal's, and Lamy's actinometers are made so as to have translucent bodies inserted in suitable apertures, in order to form an obstacle to the action of light. I do not minutely describe these very ingenious and useful instruments, because they are very well known. In some the observations are made by a comparison of the tints with normal ones; in others by reading the numbers that are printed through the obstructing medium, which is formed of translucent paper, gelatine, mica, colored glass, photographic collodion, etc.

I pass round for your examination this little photometer by M. Hermagis, of Paris, which is in the form of a locket, and is formed of a triangular prism, made of orange glass, with engraved numbers beneath. The prism is almost colorless at the thinnest, and deep orange at the thickest end. A small strip of sensitive paper is slipped between the card and the glass prism, and when exposed to the light the higher the number printed the greater is the intensity of light.

This other photometer for negative work, by M. Vidal, is also worth your inspection. This rather roughly made actinometer is my own make. The scale is made by means of collodion emulsion. To examine the number printed, the scale is slid backwards and the number is visible through yellow glass. For economy's sake only a certain portion of the scale is exposed, by sliding the aperture longitudinally.

I cannot close this chapter without showing you a highly efficient, portable, and elegant photometer recently made by Mr. Woodbury. It has the form and size of a small watch. On its surface you observe a circle divided into six sectors, with a hole in the center. The sectors are printed by Woodbury type, the coloring matter being Indian ink and alizarine (permanent). A strip of permanent sensitive paper is passed thorough the slide, *a*, at the side of the brass box, and is

* A communication to the Photographic Society of Great Britain.

acted on by light through the hole, *b*, in the center of the sectors. The strip of paper is wound round a small glass tube, *c*. Another minute glass tube, *d*, presses by means of an elastic spring on the roll of the paper, which prevents the unwinding of the paper; but by pulling the strip it easily comes out. This part is inclosed inside the box, and, thanks to this contrivance, the whole apparatus is very small. According to this author, the photometer in this form can be used for timing exposure for negatives or for other sensitive preparations. For carbon, a disk of yellow gelatine is inserted between the glass and the scale.

Mr. Lane, in his printing frame—which I pass for inspection—has also introduced a photometer, and it is an excellent plan to have such a photometer in every frame used for carbon printing.

Professor Roscoe devised a special apparatus for measuring the intensity of daylight. The apparatus, improved by

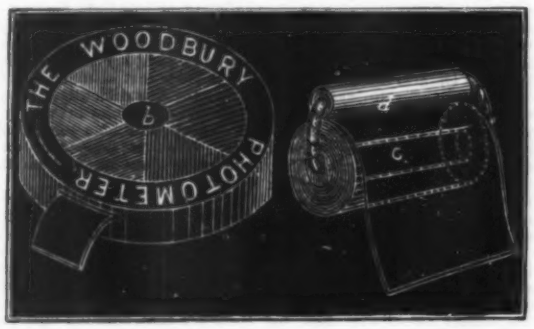


Fig. 1.

Captain Abney, was shown to this Society some time ago. It answers the purpose admirably. The strip of silver paper, as you doubtless remember, wound on the mechanically and uniformly revolving drum, is subjected to the action of light passing through a scale. A very ingenious mode of comparing the intensity of the tint is obtained, and its translation into numbers is also the work of Captain Abney.

Chloride of silver paper is also used by the majority of carbon printers. This is a mistake, as the sensitiveness of the chromium salts is subject to certain freaks, not followed by the sensitive silver paper. For instance: the temperature and the hygroscopic condition of the atmosphere have a very marked influence on the sensitiveness of the chromium preparations which is not in the chloride of silver paper.

Dr. Vogel, in his photometer, to obviate this imperfection, employed, instead of silver, a chromium salt, plain paper being used. This was immersed in—

Chromium dichromate	1 part.
Water	30 parts.

This paper when dry, will keep several weeks without alteration.

M. Leon Vidal preferred to use silvered paper, but he introduced a correction by means of separate apparatus, called by him "*Graduateur des rapports*," by the aid of which he can find the difference of action between the silver paper and the carbon tissue he intends to use on certain days.

Electro-Chemical Actinometer by Edmond Becquerel.—This *savant*, knowing the law that every chemical action between two substances is accompanied by the generation of an electrical current, came to the conclusion that, since light

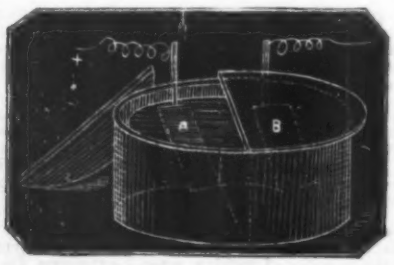


Fig. 2.

produces chemical action, this action must also generate an electrical current; hence he saw a possibility of measuring the intensity of the action of light. Becquerel used for his experiments a glass or earthenware vessel blackened inside, and having a very thin porous partition in the center. This vessel was filled with the liquid under investigation. In each compartment thus formed gold or platinum foil (previously heated to red heat) was placed, and connected with a multiplier, having 25,000 to 30,000 coils of wire. As soon as the half cover is removed and the light strikes the surface of the foil the galvanometer indicates the current by the deflection of the needle. In the case of alkaline liquids the exposed plate gives an indication of negative electricity; but in acid solutions it is positive. It is remarkable that in the case of pure gold or platinum no chemical action can take place. Various hypotheses were advanced to explain the cause of the deflection of the needle in this case; but up to now no explanation can be considered as satisfactory. It was, however, unmistakably proved that it was not heat but light, and only the more refrangible part of the solar spectrum, that produced the action indicated.

Subsequently, platinum foil was covered with thin layers of precipitated silver chloride, after which the plate so prepared was gently heated in the dark. By this means silver chloride is cemented to the platinum. When this plate is exposed to the light in the apparatus previous described silver chloride begins to darken, losing part of its chlorine, and this chemical reaction is immediately indicated on the galvanometer. The following are the data obtained during M. Becquerel's experiments:

White chloride of silver, when exposed, gave indication 7·5°; after a quarter of an hour, when the color became dark violet, 5·5°; after half an hour, colors gray black, 4·5°; after three-quarters an hour, color gray black, 4°; after one hour, color gray black, 3°; after two hours, color gray black, 2°. M. Becquerel considered it sufficiently constant during a considerable space of time to apply it to test the comparative action of light on various salts of silver. By this means it was found that bromide of silver is sooner decomposed, and gives rise to an electrical current of greater intensity than chloride of silver, in proportion as 15° to 26°. —*Leon Warnerke, in British Journal of Photography.*

PHOTO-ELECTRO METALLURGY.

[A communication to the Manchester Photographic Society.]

Actuated by the hints of our energetic Secretary, who who is always on the alert for anything to enliven and interest the Society's meetings, and taking it for granted that the members are desirous of exchanging ideas, whether strictly photographic or not, so long as something bearing upon photography is the subject, I have, with this object in view, been induced to jot down a few of my experiences, which I hope will prove interesting. This being my apology for any apparent digression which may occur from the most favored subjects, I confidently trust to your indulgence, giving my assurance that if my efforts are appreciated I shall be amply repaid. I cannot refrain from expressing my regret that such a limited number of the members assist in catering for the general fund of scientific entertainments, for which a society of this kind, above all others, should be most celebrated. I hope the spirit of emulation will continue to improve, and for my own part I shall always be pleased to do my best, even at short notice, in the event of a scarcity of practical or theoretical demonstrations.

I will commence my subject by illustrating combined chemical and electrical action in a few commonplace instances which are daily in action around us, silently but most persistently demonstrating some of the greatest principles in chemistry, but which, from want of the application of that great teacher, observation, are passed unnoticed by thousands.

For my first example I will take an ordinary tinned iron vessel used for culinary purposes. The thickness of the tin upon the iron determines how long the latter will be protected from oxidizing. After the tin is worn away from the most prominent parts, and the vessel is put out of use for a short time, the tinned portions being electrically negative to the iron, renders the tin a means of destruction instead of protection, for by one of the laws of electricity the negative metal is preserved at the expense of the positive when in contact. This electrical action would not occur to such an extent were water and iron pure; but as neither is to be thus had the impurities in both only serve to make the destruction more complete. The same action may be observed at the bottom of iron bars which have been let into stone and secured with lead. These become corroded away much sooner at the point of contact with the lead than in any other part. This happens more especially in towns where sulphur from so many fires is continually combining with moisture, forming acidulated water. In this case, also, the lead is negative to the iron; the former, therefore, is protected at the expense of the latter. Now, were the bars secured in the stone with zinc, both metals would then become wasted away equally; at any rate, both metals being positive, one would not hasten the destruction of the other.

Professor Graham, treating on the action of iron in water, says:

"Articles of iron may be completely defended from injury in this way by the more positive metal, zinc, the preserving action being continued even after portions of the zinc are worn off." I will show this action more fully by the next example, which will be illustrated by an experiment, with the exception that in this case it will not only prove the primary law already stated, but the atomic, which will be generated, will be, as it were, put in harness and made to do work.

To explain this action I will take a half-crown piece and tie some iron binding wire round it, then make it red hot in the Bunsen flame, and then quench it in the beaker containing dilute sulphuric acid. This has the effect of dissolving a small portion of the copper out of the coin, with which the silver is alloyed in the proportion of ninety-five parts of silver to five parts of copper; the quantity of copper, therefore, in the solution will be extremely small, but it will be amply sufficient for my purpose. After the coin has remained in the solution for a few minutes it will be coated or plated over with the copper which was previously dissolved from its surface. I could give numerous other instances of this simple form of action; but, as the time allotted to me is rather limited, it will be undesirable to do so, or to explain the more extended experiments which could be shown, and which only follow out the action you have already seen, unless it is to add that the various solutions of metals are almost, without exception, at the present time deposited from in a separate cell; also a separate battery or motor of electro-atomic force is used, it being only necessary to bear in mind that, in forming a battery, whatever the metals, the positive element is that which is not acted upon by the excitant, and which must, therefore, part with its representative pole in the depositing cell. The negative element being the loser in originating the force put out, it must, therefore, be the pole in the depositing cell to receive its equivalent for the loss it has sustained in producing that force.

Having been engaged for nearly thirty years in electro-metallurgy, and having practised photography at intervals during that period beginning with the daguerreotype process, it become an easy step from that art to the electrotyping of silver plates for printing purposes; and about fifteen years ago I possessed a splendid collection of specimens, which, however, through an unfortunate misunderstanding with a workman, got cut up and melted to alloy gold. Notwithstanding, at my earliest convenience I intend to reproduce them, commencing with the glyphographic process, invented by Palmer in 1842, down to the present time, chiefly embracing those processes which bear some special feature sufficient to warrant their reproduction.

Those specimens which are now before you are of recent production. With the exception of two they possess no photographic points of interest, being simply plain specimens of the deposition of copper upon fruit, the fruit being still encased in the copper. They show, however, how smooth and even a thin coating of copper can be deposited upon non-conducting objects by being simply brushed over with plumbago, then successively immersed in a solution of phosphorus and perchloride of gold.

The casket bearing so much intricate ornamentation was designed and constructed chiefly to show the various tints and shades of color which can be produced upon gold and silver by acting upon those metals, with salts and acids, producing the effect termed "oxidizing." This work has lost much of its freshness by being in an exhibition for some time without a shade. The tints of which I speak can be distinguished better by daylight.

Those pieces of silver with cardboard coverings are what are called "metallo-chromes." The observation of these pleasing effects will bring us a little nearer to photography. They are formed by depositing a film of peroxide of lead upon a polished plate of silver, steel or nickel. There is one now in the glass beaker before you, being formed by the electric current. The only account I have been able to meet with relating to these singular effects is taken from Mr. Alfred Smee's work on electro-metallurgy, published in 1843. In explaining the deposition of the oxide of lead he says: "The production of this oxide has been used by Mr. Gassiot to form metallo-chromes, which, for striking effect and beauty of colors, are unequaled by other work of art."

The small round plates with cardboard coverings are called "Nobilis' rings." These are of two kinds, the simplest form being produced by moistening a polished silver plate with a solution of acetate of copper, when on touching the plate with a piece of zinc, there becomes deposited upon the plate a number of rings centrally with the zinc, the point of contact showing no deposit.

These rings can be produced in various ways; but the same principle would appear to govern the action in all cases. They have been compared to Newton's rings, but are only similar by reason of producing decomposition of light; for in Nobilis' rings there does really appear to be in the acetate of copper form a pigmented coloring matter, which can be easily removed by a pencil point moistened with hydrochloric acid, in the same manner as removing the blue from steel. Some of those before you have been submitted to the action of strong cyanide of potassium, which did not affect the deposit, and one of them was polished with a dolly buff in a lathe for some minutes, which made very little difference to it. This seems the more striking as the rings were only a few seconds in formation and the solution very weak. The best of these chromes can be produced by depositing a film of binoxide of lead upon a plate of polished silver or nickel. The plate must be attached to the positive element of the battery, bearing in mind that the negative pole need not be of any specified form, but, whatever be its form, the contour of the chrome will be regulated by it, and according to the relative distances of every part of the negative pole so will coloring be disposed of. If the negative pole terminate in a point facing the center of the plate, rings will be formed of different thicknesses of the deposit showing the colors of the spectrum.

The foregoing arrangement must be connected up with two pint Bunsen batteries, and if the power be brisk the effect will be produced in about fifteen minutes. The solution is made by dissolving finely powdered litharge in a solution of potass; the binoxide of lead is produced by the reduction of some oxide of lead during decomposition into metallic lead on the negative pole, and oxygen being liberated at the positive pole, it combines with the oxide of lead in the solution to form binoxide, which, as decomposition proceeds, becomes deposited on the positive pole. All the prismatic colors are seen by reflected light, and by transmitted light a series of prismatic colors complementary to those seen in the first position appear to occupy their places.

Now, having read of many attempts to reproduce the natural colors of objects by photography, I have been most forcibly impressed with the idea that those who have professedly made that grand discovery have been operating with some of the sub-chlorides, acetates, or other sub-salts, and have produced a conglomeration of these same Nobilis' rings with a silver plate photograph. Hermann Vogel says, for instance: "Nicephore Niepce, who worked, like Becquerel, with plates of silver, which he chlorinated by immersion in a solution of iron and copper, and then heated them strongly, thus obtained plates which appeared ten times more sensitive than Becquerel's, and enable him to copy church windows, etc. He relates that he not only obtained the colors of objects in his pictures, but that gold and silver retained their metallic splendor, and the picture of a peacock's feather the luster of nature." Now, the mere fact that church windows and a peacock's feather are named seems to imply or suggest that the colors which were obtained were prismatic, and the half closed boxes in which these pictures were exhibited a simple contrivance to obtain the proper angle for observation, to prevent any movement showing the complementary colors. I have no explanation to offer as to how the pictures were produced; but, if the effect were based upon the prismatic operation of light, I think the achievement, from a photographic point of view, very considerably reduced in its importance. A pigmented picture is the desideratum, and there is no known law connecting chemical composition with color; therefore, there is much to be done before we can obtain these much hoped for results.

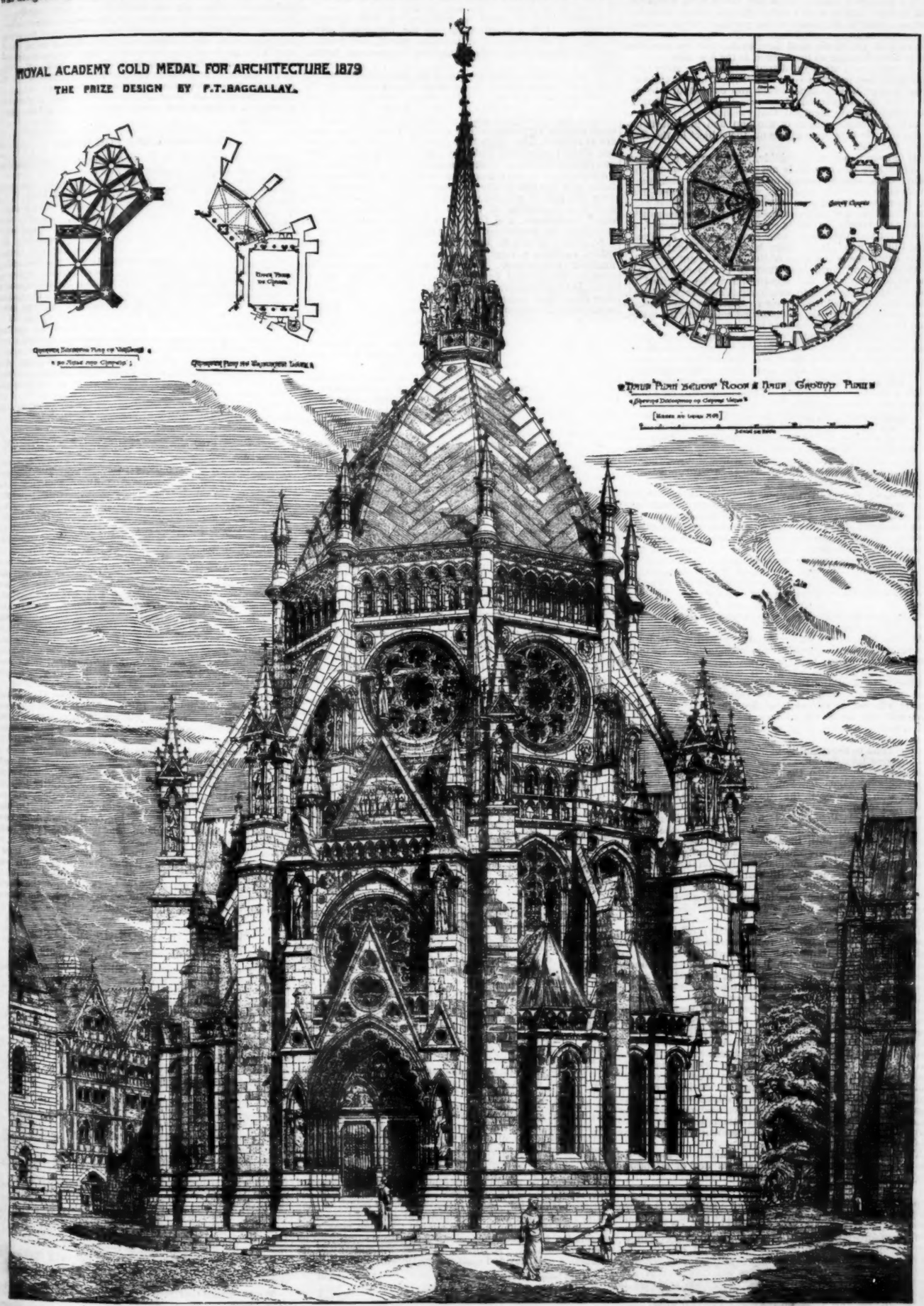
On the completion of this paper I shall show the deposition of gold on the screen by the aid of the lime light. I will explain the action when I have the subject before me, and which is now being got ready in the next room. Those who might be desirous of producing the effect which I have just named could not do better than consult Mr. W. J. Chadwick's *Lantern Manual*. His article on electro-deposition is well explained and easily followed out. In conclusion: I will only add that electro-metallurgy has done much to assist photography in introducing several forms of printing from photo-relief, etc. It may yet do more; hence it will not be presumptuous, then, in declaring that it justly deserves a prominent position on the photographic platform.

W. Watts.

ROYAL ACADEMY GOLD-MEDAL DESIGN FOR A BAPTISTERY.

We illustrate the gold medal design from the Royal Academy of Arts, for a baptistery, the author being Mr. Frank T. Baggallay. Our engraving below includes the several plans of the building, and in an early number we propose to give the author's large-scale detail drawing, as well as the extra-medal plan for the same building, which was designed by Mr. Ince. Mr. Baggallay won his prize honestly and well, and in a competition where all the designs submitted were of unusual merit. We reviewed the series in the *Building News* for Dec. 12. The following extracts from the Dictionary of the "Architectural Publication Society" may be of interest:

"By a baptistery is to be understood an octagonal building . . . adjacent to a church, but no part of it. All the middle part of this building was one large hall, capable of containing a great multitude of people; the sides were parted off and divided into rooms. . . . In the middle of the great hall was the octagon bath, which, strictly speaking, was the baptistery, and from which the whole building was denominated. Water was conveyed to one or more of the side rooms for the separate baptism of women. Some of these surrounding rooms were vestries, schoolrooms, etc." From "Hope's Historical Essay:" "Baptisteries are usually polygonal, as distinguished from the sepulchral chapels, which are circular." Mr. Baggallay's motto was "Detur Digniori."—*Building News.*



SUGGESTIONS IN ARCHITECTURE.--DESIGN FOR A BAPTISTERY.

HOP-RESIN.

THE action of oxygen on vegetable oils results, first, in the formation of a balsam, then of a resin. The former are merely mixtures of ethereal oil with resinous substances, while by further exposure to the atmosphere the oil is completely evaporated, leaving a simple resin. The artificial balsams, produced by the solution of resinous substances in volatile oils, may at some future time be pressed into the brewer's service for barrel pitching. It would not be difficult to imagine a varnish or balsam made from a tasteless resin in combination with a volatile liquid, which, when applied as a paint to the inside of the package, would oxidize, leaving the resin as a solid coating. The first of these substances with which we shall have to do, and the one that will be most familiar to the brewer, is the *hop-resin*.

It is even now a matter of dispute whether the bitter principle of the hop proceeds from a substance, hop-bitter, having an independent existence in the hop extract, or whether the bitter flavor proceeds from the hop-resin. Rautert claims that they are identical, that the hop-resin is at once the most important element of the hop, and gives it its bitter flavor. He says in an article on the subject in the *Bierbrauer*, for 1859:

"Hop-resin is not easily soluble, particularly in pure water, and where the hop oil is not present. But water containing salts, such as tannin, or gum, or sugar, dissolves a considerable quantity, especially when hop oil is also present. It was doubtless owing to this circumstance that when some time since a search was made for a bitter resinous substance that should be easily soluble in pure water, *i. e.*, lupulin, the scientists came to the conclusion that none such existed in the hop. It has since been decided that this resinous substance is the bitter of the hop; it is not very soluble in water, and constitutes from twelve to eighteen per cent. of the hop. To the hop-resin must be ascribed all those effects on the beer, to secure which hops are employed. Hop-resin is of a yellowish brown color, very much resembling brewer's pitch. Being somewhat soluble in the saliva, it has an intensely bitter taste as long as kept in the mouth. It has not yet been found possible to obtain from the hop a resin that is not bitter, a fact which goes far to explode the opposite theory as to its bitterness. Exposed in thin layers to the air, it undergoes after some time a decomposition, after which it becomes insoluble in many substances in which it was formerly soluble. This change will take place more rapidly in the sunlight."

In opposition to this, Mulder, in his "Chemistry of Beer," says: "The particles derived from the hop which we can trace and account for in the beer are the hop-resin and the hop-bitter. If we take beer and evaporate it to solidity, we can dissolve both these substances out by means of alcohol, or we can take out the hop-resin with ether first, and afterward the hop-bitter with water."

Lermer, by means of a tedious and delicate process, has lately succeeded in producing from hops a crystallizable substance, to which he has given the name of hop-bitter acid, in consequence of it showing an acid reaction when dissolved in ether. The brittle white crystals do not remain long unchanged; in twelve hours they become yellowish and soft. In water this substance is insoluble and tasteless, but the bitter principle is quickly developed if it is dissolved in alcohol and the solution then diluted with water. Whether or not it is soluble in worts, Lermer does not say. The substance requires still further study, and it may eventually turn out to be developed by Lermer's process from the resin during the process of production.

At some future time we may become acquainted with further particulars with regard to this substance, but we must remember that when beer has been left with a surplus of saccharine in it on storage it continues to ferment, and during fermentation the resin is eliminated, and the beer gradually *loses in bitterness*. The solution of hop-resin is greatly affected by the passage through the latter of carbonic acid gas, which affects its more rapid expulsion, and will account for the large quantity of hop-resin that is worked out of beer at the commencement of fermentation, in proportion to the quantity of sugar that has had time to be converted into alcohol.

Brewer's Pitch.—From the wounded bark of the fir tree a balsamic substance flows that is carefully collected, and boiled with water until the greater part of the volatile oleaginous components have been driven off. The semi-fluid substance is then filtered through coarse linen to remove chips of wood or bark, and returned to the kettle where it is boiled until the whole of the water has been driven off. Should any water remain in the pitch it will cause bubbles and an unequal coating on the inside of the packages. The brewer will bear this in mind in buying pitch. The test for water in pitch may be made by making up a cube of the material and holding it in a flame. If it be not free from water it will commence to sputter at once.

The whole of the ethereal oil is not driven off in the process of manufacture; a portion remains behind with the resin and gives the pitch its peculiar odor, varying according to the species of fir from which it was obtained. Although the chief use of the pitch is to close the seams of the packages, make them air tight, and keep the beer from contact with the porous wood, it has, according to Habich, a further utility which must not be under-rated. The pitch is said to preserve the beer by retarding the after-fermentation.

Asphalt, or the substitute for it that is generally used in the brewery, viz., the residue obtained from the distillation of coal tar, mixed with linseed oil and thinned with turpentine, has been frequently used for painting walls, while felt soaked in some such mixture has been used for roofing. This has often resulted in irregularities during fermentation, which disappeared when the obnoxious odor was removed. The cause of the trouble was doubtless the vapors of benzoline and naphtha which remained in the tarry substances, and which are well known to be injurious to fermentation.

The next class of substances with which we have to do has received, particularly of late, a great deal of attention; they are the

FATS AND FATTY ACIDS.

A simple proof of the fatty nature of a substance is shown by its leaving a permanent greasy stain on paper. They are insoluble in water on the surface of which they float—at an ordinary temperature some of them are solid like tallow, some semi solid like butter, and some liquid like oil. All of them may be reduced to an oily constituency by exposure to the heat. These fatty substances are composed of glycerine and one or more fatty acids. The fatty acids are in part insoluble, the remainder being difficult of solution in water, and they all swim on the surface of that fluid; some of them are very volatile. Among the first that are of interest to us we shall find—

Stearic Acid, Margaric Acid, and Oleic Acid.—We will use them only as illustrations of solid and fluid fatty acids. Stearic acid is largely contained in the substance of which the highly transparent wax candles are moulded, the liquid acids being expressed for that purpose. In combination with potash, these fatty substances form soft soap, while with soda they form the ordinary hard soap. In combination with glycerine they are fats. In the manufacture of soap these fats are boiled with potash lye until the fatty acid unites with the potash and forms soap, while the glycerine is found in the refuse of the soap boiler's vat.

Butyric Acid is found in combination with glycerine in butter. If by a peculiar process the butter is deprived of part of its glycerine it becomes rancid, the peculiar smell of rancid butter being caused by an excess of butyric acid.

In the brewery, generally by gross carelessness, butyric acid is developed, giving to the worts on the coolschiffe the unpleasant taste and smell called summer rancidity. It may nearly always be accepted that where a brewer complains of butyric his brewery or plant or utensils will be found in some manner very dirty. The chemical changes that occur are as follows: The component parts of butyric acid are carbon eight equivalents, hydrogen eight equivalents, and oxygen four equivalents. At the commencement of the affection a development of gas commences on the coolschiffe, and carbonic acid gas and hydrogen gas are largely given off. If from one part of glucose we abstract four parts of carbonic acid gas, consisting of carbon four equivalents, oxygen eight equivalents, and four parts hydrogen, we shall find remaining the components of butyric acid, viz., $C_4H_8O_4$.

St. John's Bread, or locust beans, as they are popularly called, contains a large proportion of glucose, but the remaining components, under certain circumstances, decompose rapidly and develop butyric acid in large quantities. During fermentation this butyric acid combines further with ether, composed of four equivalents carbon, four equivalents hydrogen, and one equivalent oxygen. Butyric ether, as it is called, has somewhat the odor of rum; in fact, rum owes its characteristic odor to the presence of butyric ether. This locust, or St. John's bread, has been known to be used by English brewers in their beer, which has in consequence developed a peculiar "rum" flavor.

Valerianic Acid, so called because first obtained from valerian root. It is worthy of the brewer's notice by reason of the volatile hop oil, changing by oxidization on exposure to the atmosphere to this acid, which gives its characteristic odor, that of strong cheese, to old hops or those that have been carelessly stored.

Fatty substances found in malt and grain next draw our attention. Although an important subject to the brewer, it has hitherto received but little attention, and we cannot treat it so fully as its importance deserves. In these days of progress, when the brewery trade has made such strides as to become a gigantic consumer of grain, a faction in the barley trade to make or mar a market causes brewers to manifest some little anxiety as to the adaptability of other cereals to their processes. Hitherto, efforts in this direction have been only partially successful. It has been found difficult to use ordinary raw grain without subjecting it to some process that is almost as costly, and to the brewer more troublesome than malting or buying malt. The least expense such experiments entail are alterations of plant, for which space is not always available, and after the risk has been run, it frequently happens that the product is inferior to the article in demand, to the loss of the brewer's reputation. The greater proportion of these mishaps may be attributed to the peculiar fatty substances of each cereal, which impart to the beverages prepared from them their characteristic odor. Corn meal, for instance, contains a larger proportion of starch than barley malt, compared bulk for bulk with the latter; which may be easily converted into fermentable saccharine with the aid of a certain proportion, say one-third to one-half, of barley malt. It has been used successfully by some brewers in the proportion of one-fifth malt to four-fifths corn meal, but until the present time the fatty substances and acids of the corn meal have proved an effective barrier to its successful application, though many brewers have experimented in its use and would gladly employ it for economy's sake. An intimate knowledge of the nature of these fatty substances would doubtlessly suggest some means of neutralizing or avoiding them, and this will certainly be achieved as the trade progresses at some future time. The most exhaustive research into the character of these substances hitherto made, is that of the chemist Stein, from whose treatise we obtain the following facts:

By means of ether we dissolve out the fatty matter from raw barley, and afterward drive off the volatile spirit at a gentle heat; we obtain a certain quantity of a reddish-yellow fat. When fresh, the smell of this fat strongly resembles that of a heap of barley, and becomes more prominent when we heat the fat in water. Wagner obtained from fresh Jerusalem barley a colorless and odorless fat, of the consistency of castor oil, while that obtained by Hanamann from a similar source was claimed to resemble in odor fresh clover.

The fat obtainable from green (unkilned) malt has a peculiarly pungent smell, while that of air-malt smells more like the barley-fat. The most interesting is, however, the fat obtainable from kilned-malt. From such malt Stein obtained always, in his carefully conducted experiments, more fat than from air-malt, tending to show that during kilning the fat had taken up some other substance. It might be supposed that it had combined with oxygen, causing a great change in its odor. If we extract from kilned malt, by means of ether, the whole of the fatty substance, and then dissolve out from the malt all soluble matter, we shall find that the last extract, though having a certain scent of its own on being warmed, is not nearly so pungent, nor is it the same as that of malt extract ordinarily; but if we add to this the first extract we obtained, viz., the solution containing the fatty matter, and again apply heat, we shall find the characteristic odor of malt extract at a lower temperature than we needed before. From the above facts we may infer, with little fear of being incorrect, that the changes of aroma that occur in grain during the process of malting from the steep to the kiln are all centered in transformations that are effected in the fatty substances as originally present in the barley. It may now be understood how the length of time during which the barley is allowed to sprout or the long growth of the plumule causes a more thorough conversion of this fat, and accounts for the better aroma possessed by well grown malt. According to Stein, the quantity of fat contained in barley and malt was as follows:

One hundred parts of barley.....	3·536
In the air malt made therefrom.....	2·304
In the kiln-dried malt...	3·106

During germination fat had therefore been expended; it consists of carbon, hydrogen, and a small quanty of oxygen; by an absorption from the atmosphere of a further quantity of oxygen, these elements would be resolved into carbonic acid gas and water. In all grain the fat goes with the albuminoids, and those parts rich in albumen are always richer in fatty matter. Barley meal contains, according to Hanamann, 0·8 to 1 per cent. of fat, while the bran or inner husk of barley contains 3 to 3·5 per cent., and that of wheat as much as 5·6 per cent. Kaiser relates, that in a distillery where a grade of maize very rich in fat was employed, if the mash was overheated drops of fat could be seen floating on the surface; at a low temperature they did not appear. Some inferences as to the cause of cloudiness in worts where the closing heat in the mash has been carried very high, may be drawn from these statements. In addition to the above it will not be out of place to recall to mind the assertion, supported by actual experiment of Mr. Pasteur, to the effect that in all vinous fermentations more or less fat is developed. To a saccharine solution free of fat he added yeast, which he had deprived of all fat by means of ether; and in the yeast developed he found from one to two per cent. of fat.—*Brewer's Gazette.*

NEW SOLVENT FOR GUMS.

SOLVENTS for gums are not so numerous that the practical worker can afford to neglect any promising line of research; and there may possibly be some advantage in the "improvement" for which Mr. W. F. Jack, of 16 Mark Lane, E. C., lately obtained provisional protection, but allowed it to lapse. It has hitherto been the practice to use naphtha and other distillates of coal tar for dissolving India-rubber and other gums, all having a pungent and disagreeable odor. Mr. Jack obtains his solvent from wood tar or the oils thereof (which have hitherto been comparatively valueless), either by distillation or by any other process, either by heat or lowering the temperature, with or without the aid of an acid or alkaline bath, preferring to use the alkaline bath at a heat varying, say, from 100° to 400° Fahrenheit; the result being an oil with a pleasant and wholesome odor, which can be used either as a solvent for gums, or by itself for lighting and heating purposes, or in conjunction with alcohol, ether, or other spirit, camphor, or other oils, singly or in combination. By mixing the solvent or the residue obtained after distilling off the lighter oils with the fatty alkaline and other materials for making soap, a soap is made of an antiseptic nature and refreshing odor. The heavier portions of the residue may be used as a lubricant, either alone or in combination with other oils.

THE ELECTRO-MOTIVE FORCE OF ALUMINUM.

THIS subject has been recently studied by Signor Malavasi, of the Modena Academy. In contact with zinc (he says) aluminum always appears electro-positive, though it is less oxidizable. In dilute acid, on the other hand, it is electro-negative. If an aluminum plate be cleaned with oil and pumice stone, it is, on contact with zinc, positive; but, if it be cleaned with water and pumice stone and dried in the sun, it is negative. On being immersed in water after the cleaning with oil, the aluminum plate is only positive at the beginning—very soon negative. In water, the aluminum plate gets coated with a gelatinous mass (iron oxide, hydrate, and clay), the zinc plate with a crust; thus both are oxidized, with the above mentioned effects. Three elements—zinc, copper, water—have the same electro-motive force as five elements, zinc aluminum. On heating the junction, the current passes from aluminum to tin, copper, antimony; thus the behavior is somewhat like that of lead. At a higher temperature, the current between aluminum and tin is reversed. Aluminum plates are not markedly polarized in a circuit, though the positive aluminum electrode is thereby quickly dissolved. If the current is passed through after the aluminum plate has remained long in water, the polarization is more pronounced. In a combination zinc-aluminum water, or dilute acid, the current mostly rises at first, even to the double, and then slowly falls; and this the author attributes to the gradually strengthening adhesion of the water to the metals, especially the aluminum; the more so that, on carefully cleaning the aluminum plate with water and pumice, the rise takes place more quickly. This is also indicated by the increase of polarization, after long immersion, on the current being passed. This does not produce an increase of conductivity of the liquid. On alternately immersing, raising, drying, and again immersing, one of two aluminum plates, that remaining in the water, appears gradually positive, like zinc. In acid water, the change of the aluminum came out more strongly than in pure water. In copper aluminum elements, especially when the copper plate is large, the injurious polarization of the latter can be partly compensated by the rise in the electro-motive force of the aluminum, so that thereby the decrease of current strength is partly prevented.

EFFECTS OF COLOR ON DISTANCE.

By C. A. BUCKLIN, M D., New York.

THAT artists unconsciously avail themselves of a universal visual imperfection in producing distance on canvas, is a fact which in interest is only exceeded by the fact that all eyes have visual imperfections.

Let us compare, experimentally, the human eye with a simple optical instrument, and we will find that the eye has even more defects than the instrument.

I. If we allow a ray of sunlight to fall upon a prism of glass, after passing through it, the ray divides itself into various colors; they are all bent toward the base of the prism; the violet rays are bent the most, the red rays are bent the least.

This demonstrates that the red rays are more difficult to bend than the violet.

II. If the light from a candle, twenty feet distant, falls upon a common magnifying glass (No. 2), the rays will be united in one point about two inches behind the lens. If we place a sheet of paper at this point we will see formed upon it a round point of light; if we carry the sheet of paper a few inches farther back, a distinct inverted image of the candle will be seen. If the candle is then brought a little nearer to the lens the image will vanish, and the former round light point will gradually take its place, which indicates that the rays are united farther behind the lens than they were. That is, by bringing the candle nearer we have made the rays more difficult to bend or unite.

Bringing the candle nearer makes the rays diverge, and diverging rays of light, as well as diverging projectiles, are difficult to make converging.

We have seen that red rays were more difficult to bend than violet.

Now we have found that divergent, or rays from a near object, are difficult to converge.

This makes it evident that *color* and *distance*, independent of light and shade, are interchangeable. A lens should unite rays from violet objects and rays from red objects at the same point; but a simple lens does not.

The discussion between Newton and Euler as to whether this error existed in the human eye, is not without interest. Newton's belief that the eye was not achromatic, and also that it was impossible to produce achromatic refractive instruments, led to his inventing and constructing the reflecting telescope.

Euler's incorrect belief that the eye was achromatic, led to the construction of achromatic telescopes and microscopes.

We have but to compare the glass lens with the lens in the human eye (as was done by Maurolycus in the last half of the sixteenth century). The sheet of paper representing the retina, the candle the observed object, and the dark space intervening between lens and paper, the dark chamber of the eye. Thus we have compared the eye with a simple optical instrument. The chromatic aberration of the human eye is considerably less than that of a glass lens.

Without referring to the details of Fraunhofer's* experiments, by which he not only demonstrated the existence of this error in the human eye, but with which he measured it, I will give you his results. At the far point of distinct vision, with the eye at rest, a violet object must be twenty-six inches nearer in order to be seen with the same distinctness as the red object. Artists all agree that independent of light and shade, coloring parts of a painting violet retires them, while coloring them red advances the same. I consider that their success in producing this effect depends principally upon this universal visual imperfection in the human eye.

If I have succeeded in calling the attention of those who have but little time to study optics to the fact that all eyes suffer from chromatic aberration, and have given them a general idea of the nature of this visual imperfection, my aim has been reached.—*Medical Record.*

ON WATER AND AIR.†

BY JOHN TYNDALL, D.C.L., LL.D., F.R.S., Professor of Natural Philosophy at the Royal Institution of Great Britain

FIFTY-TWO years ago, commencing on a day in the year 1827, Mr. Faraday gave the first course of juvenile lectures in this place, and the lectures have been continued every Christmas without interruption from that time to the present. For years before his death, when he had given up all other engagements, it was his habit to lecture every year to boys and girls at Christmas, for he thought it a most important thing that that they should not grow up in the midst of this wonderful system of nature in which we dwell without knowing something about it. There cannot, I think, be a doubt that a great deal of the interest that is now taken in the scientific education of the young may be traced back to those juvenile lectures which Faraday delivered in this room.

A knowledge of the phenomena and laws of nature is sometimes called "natural knowledge." The Royal Society, for instance, which was founded 220 years ago, announced its object to be "the improvement of natural knowledge;" and I trust that we who are here assembled together in the Royal Institution, which was founded 80 years ago, will, for the next fortnight, work cheerfully together in the great field in which natural knowledge is to be gained.

I have chosen for this course of lectures two of our most familiar substances—water and air. Water is a very common article of diet. If you take a man weighing 11 stone, and weigh the muscles of that man separately from the bones, they will weigh about 64 pounds; but if you dried those muscles, so as to convert them into a dry mass, they would be reduced in weight to 15 pounds, so that, out of 64 pounds, nearly 50 pounds are pure water. Hence I think you will agree with me that I am not wrong in stating that water is a very important article of food. Every mutton chop and every beefsteak that we consume contains water in this proportion.

But we not only thus feed upon water, but we drink it directly. Whence comes our drinking water? Well, any thoughtful boy or girl here present who had time to think would say that, eventually, it comes from the clouds. How does it get there? That question can be answered thoroughly by and by. At the present time we know, or at all events we assume, that the water comes first of all from the clouds. If you trace the course of the Thames backwards, you find that the very broad river that we have here in London is joined by other rivers right and left, until, finally, you come to the Cotswold Hills, where you find that what is here the Thames comes down to a small rivulet. This rivulet is joined by other rivulets on the right and left as you go down it, and then, at last, the river assumes the breadth at which we have it here when it reaches London. Now, this water which comes from the Cotswold Hills falls on those hills as rain. But not only does the water flow thus over the surface of the collecting valleys, and then flow to the sea in the form of rivers, but it in part sinks into the ground and percolates through the soil, and here and there appears as a pellucid spring. That is the origin of spring-water. It comes originally from the clouds, but it has percolated through the earth and come out somewhere, and there we have our clear spring.

Now, the hardest rocks are more or less soluble in water. You know that sugar and salt are very soluble; but rocks are also more or less soluble in water, so that all our river water and spring water has more or less of mineral matter dissolved in it, as sugar is dissolved in a cup of tea. Well, how do we know this? A great portion of the mineral matter may be removed from the water merely by boiling, and it is so removed in all our utensils which are employed in the kitchen. Just before the lecture I went into our own kitchen upstairs, and I looked into this kettle, and I found a thick mineral incrustation. I dare say that I can get this very hard substance out of the interior, and if you look at the interior surface of that kettle after the lecture, you will see that it is covered by this very thick crust, which is so very hard that I can hardly get it to break away. Here it is. There is a crust of this thickness on the interior surface of the kettle, and this is due to the hardness (as we call it) of the water. By boiling, a great amount of the mineral matter is precipitated and is rendered solid, and it settles upon the interior surface of the kettle, and produces that incrustation to which I have referred. Here is a copper tube which belonged long ago to a boiler at the Athenæum Club; and if, after the lecture, you come forward and examine this tube, you will find it coated so that it is almost choked up with a series of beautiful concentric incrustations of the solid matter which was contained in the tap-water supplied to the Athenæum Club and which was deposited upon the interior surface of the tube.

Not only will boiling liberate and re-solidify dissolved matter, but evaporation does the same. If you go to St. Govor's Well in Kensington Gardens, and look at where the water drips or splashes down from the little outlet, you will see a red mark where it falls. That is oxide of iron, and if you taste the water you will find that it has an inky taste. As the water splashes down, it is in part evaporated, and the iron is liberated there in the form of this oxide of iron. The reason why caverns are usually found in limestone strata is that limestone is more soluble in water than most other rocks; and if you wander, as I have done, in limestone caves, you will usually find in each cave a stream of water which has washed out the limestone and produced the cavern; and sometimes you see from the roofs of those caverns—I was going to say most beautiful icicles—but stalactites hanging down. These are due to the water which has entered into the fissures in the roof above, and percolated through the roof and dissolved some of the limestone, and made its way into the cavern, where the water is in part evaporated; and, in consequence of the evaporation, the solid matter has been deposited, and you find that, as it evaporates, these beautiful stalactites grow longer and longer from the roof toward the floor. Then drops of water fall from the end of the stalactites upon the floor, and there the water is still further evaporated, and a heap is produced called a stalagmite; and, as the water continues to drip, more and more of the solid matter is deposited below, so that the stalagmite grows from below upward, while the stalactite grows from above downward, and by and by they meet in the center, midway, with the point of the stalactite actually in the center of the stalagmite, and most wonderful and fantastic pillars are thus produced. If you visit any of the great limestone caves you will see examples of this kind. Here are some stalactites from St. Michael's Cave at Gibraltar. They are so beautiful that it seems a kind of desecration to break them. Here we have beautiful stalactites produced by the evaporation of water containing a mineral in solution, and that mineral is what we call carbonate of lime.

And now we have to examine something about this carbonate of lime. It is a body compounded of carbonic acid and lime. Everybody knows what lime is. I have here some quick-lime in this vessel. In order to show the influence of boiling, I have here water boiling in two different flasks. One of them has, perhaps, been boiling an insufficient length of time to deposit all its solid matter, but I think you will see that there is a very considerable difference between these two flasks. Now, these are two different kinds of water. One of the flasks contains water for which I am indebted to a distinguished engineer, Mr. Homersham, who has made certain water-works at Canterbury. It is the Canterbury water, which has been softened by a process that we shall learn about by and by. You see that the water in this flask is perfectly clear, because all the mineral matter has been removed from it before boiling; but the water in the other flask, which is the tap-water of our house, is thick and turbid. You see that the mineral matter has been let loose, and is forming a kind of mud, in point of fact. If I place the flask in this beam of light those at the right and the left will see that sparkling stuff, which is the mineral matter—the carbonate of lime—which has been liberated by the boiling; and it is this stuff which, when deposited upon the interior surface of our kettle, produces that incrustation to which I have referred. This open vessel merely shows the effect of evaporation. A quantity of water from St. Govor's Well in Kensington Gardens was placed in this basin this morning and evaporated, and there is the substance which gives the water its peculiar taste and its peculiar medical value. This is the substance which, when it is liberated by evaporation, produces that red splash which you see when you look at the well.

Now, we want fully to understand the meaning of this phrase that I have used—carbonate of lime. Carbonate of lime is, as I have said, a mixture of two distinct substances—carbonic acid gas and lime. I will just remind you of what this carbonic acid is. There is a quantity of it here. My friend, Professor Dewar, is kind enough to help me, and here he has been exhausting a glass globe, and here is another exhausted globe. At the present time the two globes balance each other. Now, if I allow carbonic acid to enter one globe and air to enter the other, you will find that the globe into which the carbonic acid enters will sink down. Why is that? Because the carbonic acid is heavier than the air; and it is so heavy that if put into a vessel it will lie at the bottom. Here is a vessel which is now full of it, and if Mr. Cottrell gives me a match I will see whether the gas is not there; for, as many of you no doubt are aware, it is a peculiarity of this gas that it will not support a flame. You see that the flame goes out very soon when I dip it into the gas.

Now, in order to show the weight of the gas, I will blow a soap-bubble, and throw the soap-bubble into this invisible gas. The gas is there at the present time like a liquid; and, although nobody can see it, I think you will find that when I blow the bubble and throw it into the gas, the gas will be sufficiently heavy to support the weight of the bubble. [The lecturer blew a soap-bubble from a thistle-headed glass tube, and allowed the bubble to fall into a large glass vessel of carbonic acid gas. The bubble floated about midway down the vessel.] You see that it does not sink.

Well, now, in order to show you again the heaviness of this gas, I will pour it out before you, although, as it stands there, it is perfectly invisible. I want you to have a perfectly distinct idea about it. [The vessel in which the soap-bubble had been floating was then tipped up in front of the electric light, so that its shadow was received on a white screen. The carbonic acid streamed gently downward from the lip of the vessel and cast a shadow upon the screen.] There you see the gas falling, although it is perfectly invisible under ordinary circumstances. This heavy gas falls down before you like a liquid.

This, then, is one of the constituents of our carbonate of lime. The other constituent is this ordinary lime. If you mix this lime with water, the water dissolves a certain amount of lime, and then we have lime water; and here, thanks to Mr. Homersham, I have a specimen of lime water which is obtained from the Canterbury works in a way which I will presently describe to you. Lime water is produced, as I have said, by a solution of ordinary lime in water. Lime is not very soluble. It requires about 70 gallons of water to dissolve a single pound of lime. But here we have our lime water; and if you were to taste this solution you would find it very pungent to the taste, because of the lime which is dissolved in it. Now, I wish to make carbonate of lime in your presence, and I will take this beaker, as it is called, and I will pour a portion of this lime water into the beaker. There it is. Mr. Cottrell has here an apparatus for making this substance which we call carbonic acid—that heavy gas which was poured out a moment ago in your presence. I intend to let the carbonic acid bubble through the lime water. You see, I am going to the A B C of the question, and I want to bring you from the A B C as far up as we can climb. But at first I am going to the elements of the question, and those who honor these lectures with their presence will, of course, remember that the lectures are addressed to boys and girls, and that learning or depth would be very much out of place here.

Now, I have the carbonic acid in this vessel, and I will bring it into contact with the lime water. You will then find that that clear liquid will become milky. Mr. Cottrell will allow the gas to bubble through the water, and you will see in a very short time that the liquid is rendered milky. I have placed this black cloth here [behind the vessel containing the lime-water]. It is one of the devices that we employ in order to make things visible. The change in the appearance of the liquid is due to the formation of this carbonate of lime, which is an insoluble white powder and which becomes diffused through the water, producing that milkiness which you see before you.

Instead of making the carbonic acid in the way in which it is made there, it may be made by means of marble or chalk, which are themselves carbonates of lime. Carbonate of lime is a compound of lime and carbonic acid; and if you pour upon the marble or chalk an acid which is stronger than the carbonic acid, the carbonic acid will be liberated. Everybody may do this for himself. Here I put a few bits of chalk into this vessel, and if I pour upon them a little acid, you will find that it effervesces. I do this for the purpose of enabling you to repeat the experiment for yourselves. Here is a small beaker—a small glass, and we will put into it some chalk, and pour upon it a little hydrochloric acid, and, as I have said, we shall have effervescence. There you see the mixture effervescing. Mr. Cottrell will pour into a beaker a quantity of lime water, and allow the carbonic acid gas to bubble into it. There you see the gas is bubbling through the water, and you will find that the lime water becomes milky as before.

Here we have a bottle of champagne, and I want to show you that we can make our carbonate of lime from the carbonic acid issuing from champagne. This is a bottle of Mumm's extra dry champagne. I will cut the wire and remove the cork. Here is a cork with a bent glass tube passing through it. We will put it into the bottle. The champagne is not very well up, so we will stir it a little. [The bent tube issuing from the neck of the champagne bottle was held with its farther end in a glass vessel of lime water (S), so that the gas given off by the champagne might bubble into the solution. In a short time the lime water became turbid, as in previous experiments.] Here we have got our chalk produced from the carbonic acid of the champagne.

And now I want to show you that carbonic acid is also a gas that we exhale from our lungs. I will take this small vessel and pour a little lime water into it, and then simply blow into the vessel. We inhale the atmospheric oxygen, and, after this has done its work in the body by burning part of the body, we exhale carbonic acid. Here we shall have the carbonic acid coming from my lungs, which carbonic acid will unite with the lime in that water, and produce carbonate of lime or chalk in your presence. [The lecturer blew into the lime water by means of a glass tube.] You see a single inhalation is sufficient to produce this chalk by the carbonic acid from the lungs.

Now I am about to approach a very important point, and that is a point that practically bears upon the question of the solution of minerals in water. This thing which we call carbonate of lime exists in two forms. It exists as a single carbonate, which takes up a certain amount of carbonic acid; and it exists as a double carbonate or bicarbonate, which takes up twice as much carbonic acid. I say that the carbonate of lime exists in two forms—the single carbonate and the bicarbonate; and what you have now to remember is that the single carbonate is almost insoluble in water, and that the bicarbonate is very fairly soluble in water. What is the consequence? The water coming from the clouds has always a certain amount of carbonic acid dissolved in it. When such water falls upon our chalk hills, what occurs? It soaks into the chalk; it percolates through the chalk; it dissolves the chalk; and the chalk so dissolved in the rain water is present as a carbonate of lime. If the carbonate were to remain in the form of single carbonate, the rain water could hardly dissolve it at all; but, as it is converted by the rain water into the condition of bicarbonate, the rain water dissolves a great deal of it. The conversion of the carbonate from the single carbonate to the double carbonate renders it very easily soluble in water. I have here some water from the neighborhood of Canterbury, where there is a well from which is pumped a million and a half of gallons every day from the body of the chalk. Here is the hard Canterbury water, and I pour a quantity of this hard Canterbury water into the beaker. Now, I say that the lime there is in the soluble form. It is in the form of the double carbonate, or the bicarbonate, which is another expression for the same thing. Now I have here some lime water. This Canterbury water is beautifully clear and is pleasant to the taste, but you would find it exceedingly difficult to wash in this water. In point of fact, if you operate with soap in this water you find it very difficult to get a lather in it. For a certain time you cannot possibly get a lather. That water contains, I should say, more than 20 grains of carbonate of lime dissolved in every gallon. Where washing operations have to be carried on, on a large scale, with this water, an immense amount of soap is wasted, not to wash, not to cleanse your hands, not to cleanse your linen, but simply, first of all, to remove the lime from the water before the water can produce a lather, and before the water can be used as a washing medium. Well, now, the question is, how is this to be rendered soft? Or, can this water be rendered soft on a large scale, or in an effectual way? Yes. That question has been answered in a most satisfactory manner by Dr. Clark, of Aberdeen, and he has invented a process for the softening of water, which, I think, is likely to come into great request in the future. At first sight it is a very extraordinary process; for what does Dr. Clark do? He takes the lime from the water by putting more lime into it. Now that appears to be a strange assertion; but give me your attention, and there is not a boy here present that will not understand what I mean by that expression. There [pointing to a vessel of hard water] is the lime in the form of what we call bicarbonate. There [referring to another vessel] is the lime, not united with carbonic acid at all, but

* Helmholtz: "Optische Fehler des Auges." p. 85.

† Being a course of six lectures adapted to a juvenile auditory, delivered at the Royal Institution of Great Britain, Christmas, 1879. Specially reported for the *Journal of Science.*

as lime water. Suppose I pour a quantity of that lime water upon that hard water.

There is nothing in Science which is more instructive, or more interesting, or more inspiring, than the power of previsionthe power of looking in advance—the power of allowing the mental eye, so to say, to go before the eye of the body. Now let us consider what is likely to occur if I pour this lime water into that hard water. The lime in that lime water will take away half the carbonic acid from the carbonate which is present in the hard Canterbury water. What is the consequence? It will convert the bicarbonate into simple carbonate. What again is the consequence? The simple carbonate, being insoluble in water, will appear as a milky mass in the fluid. I should not be satisfied if every boy did not understand me in this most important process. Here we have the lime water. By adding this pure lime water to the hard water we take away half of that carbonic acid which enables the lime to be dissolved. Then we convert the soluble bicarbonate into the insoluble simple carbonate, and down it goes as a milky mass, and the change is shown in your presence in that way. There is the lime which has been separated from the hard water. This is precisely the process used by Mr. Homersham, at Canterbury, and at Caterham and elsewhere. I have gone specially to all those places to see the water softened, and a more beautiful process you could not imagine. Take the case of Canterbury. You go there into a space which is perfectly clean, covered from all contact with the dust or *débris* of the air. You see there three great reservoirs. Each one of these reservoirs is capable of containing 120,000 gallons of water. You go into a little adjacent room and you see there a small reservoir, and in it you see a beautifully clear liquid; but the probability is that in all the reservoirs you will see a beautiful white powder. The small reservoir is used purely for the purpose of making the lime water. It contains the lime in a very fine state of division, and mixed with water, and therefore called "cream of lime." After being mixed with the water, the lime is allowed to stand, and the solid undissolved lime subsides to the bottom, and you have a beautiful transparent lime water above. The hard water is pumped from the wells in the chalk, and is then allowed, first of all, to be mixed with a measured quantity of this perfectly transparent lime water, for the proper quantity is perfectly well known; and then instantly you have a beautiful fine whitewash produced in the reservoir, something similar in fact to this which has been produced in this vessel, and produced precisely in the same way. The mixture of the two transparent liquids produces this whitewash. The mixture is allowed to rest for twelve, or, better still, twenty-four hours. The carbonate of lime which has been liberated sinks slowly to the bottom, leaving a liquid of the most exquisite purity and softness on the top. The carbonate of lime is taken away, and the hard water is in this way converted into soft water. In the bottom you find a powder consisting of carbonate of lime; and here, thanks to Mr. Homersham, I have some of that beautiful powder. It is as fine as the finest flour. Bakers in general, I believe, are thoroughly honest men, but one would not like this fine powder to fall into the hands of a thoroughly dishonest baker. It is so very like flour that he might materially adulterate his flour by means of this beautiful carbonate of lime. This is the carbonate of lime that has been separated from the chalk water at Canterbury, and deposited at the bottom of the reservoirs.

But now the thought occurs to me, as I am speaking to you, to give you an opportunity of exercising this power of prediction, this power of prevision, of which I have spoken. And here I will take, first of all, a little of the lime water and mix it with some distilled water. And here is some carbonic acid gas. Now I am going to ask you to turn prophets. When I allow the carbonic acid to enter the mixture of lime water and distilled water, what you have already observed will occur. We shall have the liquid converted into a milky mass; but will this be due to the precipitation of bicarbonate of lime, or to the precipitation of single carbonate of lime? Which? Somebody lisps out "The single carbonate." I wish he had courage enough to say it out. It is the single carbonate; and here is the point which I want you to predict. Suppose I continue to pour a sufficient quantity of carbonic acid into the water: suppose I continue to supply the carbonic acid: what will occur? The single carbonate, having plenty of carbonic acid to take up, will be converted into the bicarbonate, and after having first of all precipitated the single carbonate, we shall convert it into the bicarbonate and re-dissolve it. And that is what I am going to try whether we can do. Here is our liquid, and here it is being rendered milky—very milky indeed—by means of the carbonic acid gas. And now, if you will give me your patience for a time, I am strongly inclined to think that, by the continued addition of the carbonic acid, we shall convert the single carbonate into the bicarbonate, and that that milky liquid will be rendered perfectly transparent by the solution of the single carbonate. Now, this is one of the things which men of science, and which boys learning science, ought to be able to foresee. If our principle be true, then, by the addition of carbonic acid to the milky liquid, we shall convert the carbonate into bicarbonate. [The addition of carbonic acid was continued until the milky-looking liquid became clear.] This is now bicarbonate. If I pour into this liquid some lime water, I shall rob the bicarbonate of half its carbonic acid, and convert it into the single carbonate. [The experiment indicated was performed.] Here you see what occurs. You have the single carbonate in this insoluble form produced thus before you. Now, it is not for the purpose of amusing you that I bring this before you. It is for the purpose of bringing before your minds the manner of the reasoning of scientific men—the strictness of their logic—the incessant appeal from reason to facts by which they verify what they conceive.

I will now perform a very homely experiment, but still a very useful one. I want to give you some examples of the quality of this Canterbury water. Here are two basins in which I intend to produce a lather if I can. We will place in one of those basins some of the soft Canterbury water, and we will place in the other basin the ordinary tap water of the Royal Institution, and I will wash my hands, with your permission, in both basins, and then we shall see where the best lather is produced. What you will observe is that, with a very small amount of soap, I shall be able to produce a very good lather in the soft Canterbury water; but I shall not be able to produce any lather in the hard water of the Royal Institution by the amount of soap that I communicate to it. You will find, perhaps, a little lather—a few bubbles at first, but they will speedily disappear. You will find that upon the soft water a beautiful lather of soap bubbles is formed, and on the other there will be a very greasy mass, which will be due to the combination of a certain acid in the soap with the lime of the water. The acid is called margaric acid, and the curdy mass which is formed is called margarate of lime. Here, from a very small amount of soap, you see a very beautiful lather is produced in a moment in the soft water. A permanent lather covers the bowl of water. I go to the other basin and operate in the same fashion, and I obtain some few soap bubbles at the top, but they will soon disappear; and I see floating on the top and mixing with the water a quantity of this curdy, unpleasant-looking stuff that I have spoken of as a margarate of l me. Now, with a glass tube, I will blow into this lather [that produced from the soft water], and I get a very splendid and permanent heap of bubbles. In the same manner I blow into the basin containing the tap-water, and you see how few bubbles are produced, and their rapid disappearance.

I have now to say a word upon some of the other properties of water, and first we will take its color. The color of water is a delicate blue. If you pour water into an ordinary glass you see nothing of the color of the water, but in large masses you can see the color, or, at least the color can be revealed. For the purpose of showing the color of water I have here a tube 15 feet long, and that tube is partly filled with water. But before we deal any farther with the color of water, I should just like to say three or four words with regard to color in general, and for that purpose I will show you, if I can, on what all color depends.

I have here in this camera a little artificial sun [referring to the electric lamp]. If we take the light of the sun at noonday on a cloudless day, we call the light which it gives white light. Sometimes, as the sun sinks toward the horizon, his rays become red; but at noonday, when there are no clouds, the light is white. Our little domestic sun (the electric lamp) is precisely of that kind. We cause the light from our little domestic sun to impinge upon our screen. I take for this purpose simply a little strip of light—a slice of light, if I may use the expression—and there that slice of light is thrown upon the screen and produces that white rectangle which you see. I will interpose in the path of the light some colored glasses. Here I have a green glass. Well, you see that now the light on the screen is green. Here I have a blue glass, and that causes the light to be blue; and here I have a red glass, and that causes it to be red. What I want you to understand is that the blue and the green and the red are all in that white light. And now I want to pull those distinct colors one from the other. I want to separate the colors which produce that white light. I do that by sending the light through a body of a certain shape, which is called a prism. We will cause the light to pass through it. [The experiment was performed, and the usual spectrum appeared on the screen.] Is not it lovely? I have seen it a great many times, but never without wonder at its beauty. But now I want to make that longer. I will send the light through another prism. Here it is. You will observe that by using this other prism I can manage to make my colored image a great deal longer. This colored image which I obtain by sending the light through the prisms is called the spectrum; and the great Sir Isaac Newton proved that the slice of white light that you saw a moment ago upon the screen has contained in it all that numerous mass of colors which appear in the spectrum. Now, I wish that I had a ruddy faced boy that I might cause him to pass through that spectrum. You would find his ruddiness varied very much in passing through the various colors. I want to bring before you the fact that the color of a body is owing to the color which it throws back to the eye. Take a rose. When the white light of the sun falls upon the rose, it enters the rose some depth, but, as it is ejected again from the rose, certain colors are quenched, and certain colors are sent back to the eye, and the color of the rose is due to the color sent back to the eye.

Why was the red glass red? Because it quenched the other colors, and allowed only the red to pass. And what is true of red glass is true of red cloth, or of any other color. Now, I want to show you that these colors are thus quenched. Here I have a beautiful piece of red cloth. It is now vividly red in the red light of the spectrum. But why is this red cloth red? It is because it quenches the other colors, and sends the red color back to the eye. If we pass it on to the green part of the spectrum it will send back no color to the eye, and there it is black. Again, we will take the opposite experiment. Here is a piece of green silk. The green silk is green because it quenches all the other colors except green, and sends the green color back to the eye. When this green silk is placed in the green part of the spectrum it is, you see, a vivid green. Now I place it on the red part, and there it is simply black. Thus the color of a body depends partly upon the colors quenched by the body, and partly upon the colors sent back to the eye.

Now, Mr. Cottrell has here a little apparatus—simply a cell—and his object in handing it to me is that I may show you the influence of depth in producing color. Water is so feebly colored that, in order to make its color evident to you, I have been obliged to have that long tube. You see the color sometimes on the glaciers of Switzerland, in beautiful blue pools of water. Perhaps very many of the boys present will, when they grow older, visit the coast of Naples. Very likely they will go the end of the Island of Capri, and there they will find coming down the steep precipitous coast, at a certain place, a little arch, just large enough to admit a boat. You pass underneath this arch, and you find yourself under a huge grotto, the walls of which shimmer in magic beauty, with the most delicate azure light. The reason is, that in consequence of the smallness of the passage, the light is unable to get into the grotto by the entrance, but it first plunges into the blue sea, and then comes up again and illuminates the cavern, so that it has to pass through twice the depth of the water before it reaches the grotto, and, in consequence of the depth of water through which it has to pass, it gets colored blue. When I say that the light is colored blue, I mean that its red and yellow and orange and all the other rays except the blue are cut off by the water, and only the blue remains. Now, the experiment I am about to show you is simply to illustrate the influence of depth. Here is a cell composed of a thin chamber; here is one somewhat thicker; and here is one thicker still. The spectrum is on the screen, and if I simply interpose this thin cell, containing a light blue liquid, in the path of the beam you see that it has very little effect indeed upon the spectrum; and the reason is that the stratum is so thin that it cannot rob the light of its rays. Now, I will pour more of this blue liquid into the thicker cell. You observe now that by thickening the layer I have cut away the red ray altogether. You see how little light remains if I make the layer still thicker; and if I went on in this way I should actually cut away the whole spectrum with a substance which, when used in a thin layer, has hardly any effect at all upon the light. In a drinking-glass the water is not in a sufficient mass to give a color to the light. But in the tanks at Canterbury it is a most delicate sky-blue. If you drop a pin into one of the tanks, which contain 120,000 gallons each, you can see the pin lying at the bottom. I have thrown farthings into the tanks over and over again, and they are scarcely dimmed by the depth of 16 ft. of this beautiful chalk water; and this water has many other things to recommend it. For instance, I have looked into the Report of the Registrar General for information with regard to the influence of temperature upon Thames water, and I have found that, in the early part of the month of June last year, the temperature of the Thames water rose from 60° to 67° or 68°, and that the death rate from a certain complaint was at first represented by the number 23, but it rose up in three or four weeks to 349, and this increase the Registrar General attributes entirely to the rise in the temperature of the Thames water. Now, one great advantage of this Canterbury water that comes from the body of the chalk is that its temperature is perfectly constant. It is always at an agreeable temperature of 51° to 52°; and if it is properly laid and conducted to the houses it cannot possibly be the propagator of any form of infectious disease.

But now I pass on from the temperature of the Canterbury water to show you the color of the water. I have filled this long tube to half its depth with the water, so that half the beam of light which passes through the tube will go through the air, and the other half will go through the water. [The 15 ft. tube to which a reference had been made in an earlier part of the lecture, was used in this experiment. The beam of light, after passing through the tube, was received on a white screen. A light green tint was communicated by the water.] There we have a great deal of color due to the purest water that we can find.

Now I want to point out to you another physical property of water. The liquid state of matter such as water represents is sometimes defined to be that state in which cohesion is absent—a state in which the particles do not cohere, and in which they are perfectly mobile and are not held together by any force. I would ask you to remember that that is an erroneous definition of the liquid condition. The liquid condition is this: The little particles of water (and I shall tell you in a future lecture what these particles are called, but for the time being we shall call them "particles") are gifted with the power of sliding over each other; but, while gifted with that power, they can exercise a very great resistance to being torn asunder. We may measure the cohesion of water by a simple apparatus. Here is a plate of glass, and we can easily balance that plate of glass by a weight (w), and then bring the glass down upon a sheet of water; then, by adding more weights upon the scale pan, we can determine the weight necessary to sever one part of the water from the other. Take the case of a soap-bubble. If I had time I could show you the beautiful zones of color which a soap-bubble produces; and, by means of the zones of color, we can approximately determine the thickness of the bubble. You sometimes see a heavy drop of water pendent from a soap-bubble; and if you reflect upon this you will see that the film of the bubble must have a tremendous amount of tenacity in order to support the drop of water which hangs from it. Prof. Henry, of Washington, estimated the tenacity of water at several hundred pounds per square inch. But you will say, perhaps, that the soap confers this tenacity upon the water of the bubble. Well, Prof. Henry says that it is not so, and that water, if properly dealt with, is really more tenacious than water with soap in it. But, however true that may be, I want, at all events, to show you that we can get beautiful bubbles and beautiful films of water without any soap whatever.

Here is a tube connected with a cistern at the top of the house, and I am going to make an experiment with it upon a grand scale. It is an experiment which was made by an eminent French investigator, M. Felix Savart. Savart produced films of water by allowing jets of water to fall upon small surfaces. It is wonderful what care we must take in this experiment. The slightest agitation would destroy the beautiful films which it is our object to produce. I will turn the water on and allow it to fall, or to impinge, as we call it, upon this little brass plate. [A stream of water from the end of a lead pipe was allowed to fall on the center of a circular flat brass plate, which was supported by a brass pillar standing in the center of a large concave metallic pan. The water, upon reaching the brass plate, was spread out in all directions, and fell as a continuous film, the shape of which was for the most part dome-like, but occasionally became nearly globular.] Now you have that beautiful umbrella—that beautiful parasol of water. You observe the tenacious way in which the water clasps the stem. [The experiment was repeated with two plates of larger sizes. The falling water was illuminated by a beam of electric light, the beautiful effect of which was varied by the light being caused to pass through colored glasses.] I see that there are small bubbles of air coming down with the jet of water, and that is the cause of the film breaking so soon; but still it is very beautiful. I do not want you to underrate it at all. Well, this illustrates the tenacity of water where there is no soap mixed with it in order to give it tenacity.

IMPROVEMENT IN TELESCOPES.

KARL FRITSCH and Joseph Forster, of Vienna, Austria, have invented the following improvements in telescopes:

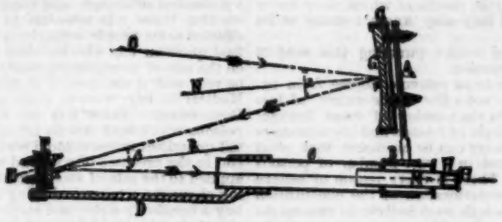
In the ordinary construction of telescopes heretofore employed, the small and large mirror—that is to say, the reflector and object mirror—were mounted within the telescope to avoid the effect of detrimental rays of light in the observations. We have found, however, that without impairing the power of the instrument both these mirrors may be located outside of the tube when properly arranged, by which arrangement the instrument may be made smaller, lighter, cheaper, and more portable than heretofore.

In the accompanying drawing, showing a section of a telescope constructed according to our invention, C is a short tube, carrying within the usual eye-piece, H', and a standard, B, supporting a plate, A, the standard being connected with the tube by means of a sleeve or other suitable means. The plate, A, supports a frame, G, which carries the large object mirror, G', which may be adjusted relatively to the object to be reflected by three set-screws, which connect the frame with the standard plate, A. This mirror is supported upon the tube at a point near the eye-piece, and upon the opposite end of the tube is mounted, by means of a sleeve or otherwise, a supporting bar, D, carrying a plate, E, which, like plate, A, supports a frame, F, within which the small reflector, F', is mounted, and the latter, like mirror, G', may be adjusted by means of set screws.

The mirrors are preferably made of polished glass and silvered in the usual manner. Their surfaces may be spherical or parabolical, or the small mirror may have a concave, convex, or plane surface.

When the mirror, G', has been adjusted relatively to the object to be viewed and the small mirror relatively to the large one, and supposing the object to be viewed to be at O,

the large mirror is facing said object and the small one the eye-piece and large mirror, the optical effect being as follows: The ray falling from the object on to the center, *s*, of the large mirror will not be reflected on the normal line, N, but at an angle with such line and with the line, O *s*, upon the center, *x*, of the small mirror, and in a similar manner the image reflected by the small mirror is not reflected on the normal line, R, but at an angle to said line, as well as to that of line *s x*, so that the reflected image may be viewed through the eye-piece.



IMPROVEMENT IN TELESCOPES.

It will thus be seen that the ray, O *s*, forms a determined angle, *d*, with the reflected ray, *s x*, and the ray, *x* M, also forms a determined angle with the ray, *s x*.

It will also be observed that the large mirror is not perforated as usual, and in this manner the most effective part of it is preserved; nor does the small mirror lie in the normal line of the center of the large mirror, by which arrangement the best part of the latter may be made use of.

[Continued from SUPPLEMENT, No. 219, page 3490.]

OUR DOMESTIC POISONS.

By HENRY CARR, M. Inst. C.E.

HOW ARSENIC POISON IS INTRODUCED INTO PAPERS.

The colors in which arsenic is an essential ingredient are Scheele's, Vienna, or emerald green (practically the same thing, no matter what name it is called by), a blue (not containing copper), orpiment (containing 60 per cent of arsenic, an expensive color now seldom used), and perhaps some few others; but it is by emerald green, used either alone or in combination, that arsenic is principally introduced. It is, however, also used without absolute necessity in a great variety of colors—red, brown, some blues, pink, low-toned greens, French grays, black, and notably in magenta; and colors are made arsenical where there is no occasion for it, merely by using up arsenical remnants which happen to be left on hand from other work. There is no doubt that in any factory where arsenical colors are freely used for certain purposes, all the papers made will be more or less contaminated, thus accounting for the slight trace frequently found. Color, therefore, cannot be taken as any guide to the public as regards freedom from arsenic. It is said that greater depth and sharper lines are obtained in black by the use of arsenic. The two samples now exhibited are from the same maker—the non-arsenical, if anything, somewhat the sharper and better of the two. These two, the black and olive green papers, are a good sample of the carelessness with which such a virulent poison is introduced into our houses—the one arsenical, the other practically free; the one as good as the other, and both from the same maker. Permanency of color is a matter of importance, and is one advantage stated to arise from the use of arsenic; but there is another side to this question, that is to say, if the public make use of fabrics colored with poisonous pigments, it is a very questionable benefit their being the longer exposed to them, and their superior average of durability is certainly very questionable, when the number of arsenical papers which it is now thought requisite to remove is taken into the calculation.

It may be safely asserted that paper stainers would suffer no injury in the home trade, from an Act of Parliament entirely prohibiting the use of arsenic, except as regards the stocks in hand; this, however, would in many cases be a serious matter, very large stocks of arsenical papers being held by some makers. Were an act suddenly passed prohibiting the sale of arsenical papers, either the manufacturers must be compensated or they must sustain a heavy loss; the only alternative being that time must be given to sell the stocks in hand, the public being allowed to imbibe so much more poison, in order that the paper stainers may be secured from loss. Continued additions to their stocks of arsenical papers will, however, for the future, be a matter for their own consideration at their own estimate of the risk.

Some paper stainers have abandoned the use of arsenical pigments for a length of time, others are now ceasing to use them, and are supplying papers guaranteed free from arsenic, stating that this change is made on account of the public feeling in the matter. It is, therefore, to be hoped that all may soon follow the same course, for it will be to the makers of non-arsenical papers that, at all events, the intelligent portion of the community will look for their decorations.

The foreign trade, however, is a more difficult question, for it is well known that a shade of color or a very small percentage of extra cost will turn the balance of the market. It seems clear that papers cannot be made of the particular shade of Scheele's green without arsenic; and though the precise color is of no real value, the color, together with the merest trifle in cost, may turn the balance in competition with foreign manufacturers who do use it. Therefore, as regards foreign trade, the real point will come to this—Shall the English manufacturer continue to export poisonous papers for the benefit of the trade of this country, irrespective of the effects on the foreign purchaser? This question seems to be settled in the affirmative, if we may judge by the course taken with regard to the opium trade. For the sake of £6,000,000 of Indian revenue, we continue to export that which is well known to be most deleterious to the Chinese nation. But, as regards home regulations, the opposite course is being followed to such an extent as to have become a settled principle of government.

The Sale of Poisons Act and the Adulteration of Food Act establish the principle that the purchasing public shall be defended by the Government from the careless or nefarious vender. If our Government thinks well to protect the public from water being added to their milk, is it too much to ask that our houses may be defended from arsenic? If druggists selling poisons are obliged to label them as such, is it unreasonable to require that arsenical fabrics shall be marked "arsenical?" Is there any reason against their being so marked, except that they would not sell? If there be no other reason, it proves that in the opinion of the venders, a large portion of the public are sufficiently alive to this question not to use these papers if aware of their nature.

Some paper stainers state with the most perfect confidence that they do not use arsenic at all on their works, which is perfectly true as regards "crude arsenic;" in that condition arsenic is not used by paper stainers. The manufacture of colors is a distinct trade, and it is the color manufacturers who introduce the compounds of arsenic, passing them on to the paper stainers in the form of arsenical pigments, which the paper stainer may not know to be arsenical if not inquired into. Some paper stainers, who desire to avoid arsenic altogether, report that they find considerable difficulty in procuring pigments free from it, and find it requisite not only to contract for colors free from arsenic, but also to watch and test the colors delivered. On this question, however, the following statement from a paper stainer is satisfactory: "Since the question of arsenic has arisen the attention of the color manufacturers, mostly abroad, has been given to the subject, and they have produced colors guaranteed free from arsenic, so nearly equal in brilliancy that the general public could not detect the difference except by such a close inspection as they are not likely to give. These non-arsenical colors do not add to the cost." Another paper stainer would rather say, "Not to any serious extent." The ceasing to use arsenical colors would not involve any expense in alteration of plant; this is a matter of some importance.

The samples now exhibited prove that there is no difficulty in producing the most satisfactory colors free from arsenic, and, as regards the home trade, the question of cost is decided by several firms having entirely abandoned the use of arsenical colors, and still holding their ground satisfactorily in the open market. In fact, it is now stated by them that, with the present feeling of the public on the subject, it is more advantageous to abandon the use of arsenical pigments, and to issue the goods guaranteed free from arsenic. The only real difficulty, therefore, as regards the home trade, is that arising from the stocks on hand. Some paper stainers give it as their opinion that the present movement is altogether a mistake, and that injury does not arise from this cause; but, even among these, some have already abandoned the use of arsenical colors, others use emerald green and such pigments as cannot be produced without arsenic, avoiding them wherever, in their opinion, it is feasible.

One paper stainer writes:

"We may state that we have not used any emerald green for a long time, and we take every precaution to purchase such other colors as are guaranteed to us free from arsenic."

Another writes:

"I exclude all arsenical colors most carefully. Nine-tenths of the colors I use are made in Germany and Belgium, and are guaranteed free from arsenic; nevertheless I also have them tested by a public analyst in this country."

A third has for some years abandoned the use of arsenical colors. Another says:

"There is difficulty in obtaining colors free. We do our best to avoid arsenic."

Another has issued the following circular:

"The subject of arsenic in wall paper having been so prominently brought before the public in the last few months, we have repeatedly been asked whether those manufactured by ourselves contain it. We have always been able to prove to the satisfaction of inquirers that there is no arsenic in wall papers of our manufacture, but with a wish to completely satisfy our customers that such is the case, we invited a chemist who had previously devoted much time to the subject of arsenic in wall papers, to thoroughly examine our manufactures and the materials used for the same. We have now pleasure in sending you a copy of his report."

In reply to the question, "What disadvantage does a manufacturer who does not use arsenic suffer under?" the following reply has been received from a firm manufacturing on a large scale: "None whatever, but the contrary, as long as the present feeling exists. We have found it desirable to issue our price lists this year with a printed label to the effect 'that the patterns are made from colors guaranteed from the manufacturers free from arsenic.' It never has been any advantage to use arsenical colors, and as soon as others were produced we discontinued them."

The above quotations may be taken to a certain extent as expressions on the part of the trade, and from them it may be fairly gathered, that there would be no difficulty whatever in the total abandonment of arsenical pigments as regards wall papers.

A caution, should, however, be given that the assurance of a manufacturer that a paper is free from arsenic cannot always be relied upon. A paper selected by the writer, marked "non-arsenical," was, after being hung, pronounced highly arsenical by Dr. Stenhouse, and this from a first-class London firm of the highest respectability. A specimen of this paper is now exhibited.

The fact is that many paper stainers do not appear to be well informed as to whether their colors are arsenical or not, and it may be safely assumed that the retail dealers know very little indeed about the matter—that is, judging from the erroneous assurances so constantly given.

On the whole it may safely be said that there is a general apprehension among manufacturers of wall papers, even among those who do not admit the injurious effect of arsenical colors, that the public are getting too much alive to the question to allow of arsenical pigments being employed as heretofore with profit to themselves.

It has been suggested that it may be well to turn to distemper as a security against arsenical papers; this, however, is no security, for arsenical colors are used in distemper.

In dyeing and calico printing arsenic is used as well as in wall papers, but not to the same extent as regards arsenic remaining in the fabric when finished; and there cannot, it may be presumed, be any objection to the use of arsenic in certain processes where it is thoroughly washed out in the after stages, or where the trace left is so small as to be practically of no consequence. There are, however, some processes included in dyeing in which the pigment, to which the color is due, is itself an arsenical compound, as for instance the arsenical compounds of copper producing bright green dyes or rather pigments, the color being due to the arsenical compound attached superficially rather than entering into the body of the material as a true dye. In this condition the poisonous material would of course be less firmly fixed, and would be liable to produce the symptoms described by Dr. George Owen Rees, in a letter to the *Times*, as occurring from bed curtains and green muslin colored with Scheele's green, a square yard of which was found to contain upwards of 60 grains of the coloring matter. Chromic and ferric arseniates, which form brown and green colors, were found by Mr. Foster (Professor of Chemistry, Middlesex Hospital), to the amount of 45 grains per square yard, and 120 grains in the lining.

Arsenic is also used in dyeing in the process still called "dunging," though the material formerly used, cow-dung, has ceased to be employed. The object of this process is to remove superfluous mordants, which arise from an unavoidable excess put on in the previous stage. Instead of cow-dung, solutions of phosphate, silicate, or arseniate of soda are used; of late years, principally the latter. Here the arsenic is of use only as an intermediate agent; it forms no part or ingredient of the final color, and it is or should be removed in the subsequent stages.

There is, however, another method of producing printed fabrics, in which a much larger quantity of arsenic is used. This is in fixing the aniline colors, and it consists in printing upon the cloth a thickened mixture of red liquor (alumina acetate), a solution of arsenious acid in glycerine and a solution of the aniline color. This printing mixture may sometimes contain as much as 8 oz. or 10 oz. arsenious acid per gallon, and a piece of 25 yards might hold upon its surface immediately after printing as much as 2 oz. of arsenious acid. After printing the goods are steamed, by which means an insoluble alumina arsenite is precipitated on the fiber, and this acts as a mordant retaining the coloring matter, and fixing it on the cloth in such a way that the colors will resist soaping. This is a most objectionable process, but is not so much in favor with printers as it was some years ago; the chief advantages of the process are that by it the colors produced are very pure and brilliant; for fastness it cannot be much recommended. Even in this case, if the goods have been well washed and soaped, the whole of the arsenic remains in combination with the alumina, and is, therefore, firmly attached to the material. But when, to avoid expense, the calico printers send their goods into the market without the subsequent soaping and washing, they may contain considerable quantities of arsenic in a loose, and therefore most injurious condition. There are several other methods in use for fixing these aniline colors which are free from this objectionable use of arsenic.

The two processes, that of coloring with an arsenical pigment such as Scheele's green, and that of removal of excess of mordant by means of arseniate of soda, may be pointed out as examples of two entirely different operations. The one in which an arsenical compound constitutes the permanent coloring is decidedly to be condemned, for the arsenic remains an essential ingredient in the finished fabric. In the other process the arsenic is not an essential part of the finished goods; it is or ought to be removed in the after stages; if so removed, no injurious effect could arise from it, and the ordinary processes of manufacture ought not to be interfered with. The question, therefore, as regards dyeing, is not quite so simple as in the matter of wall papers; in them, if used at all, the arsenic must remain in the finished material, and such processes undoubtedly ought to be condemned; whereas in dyeing, temporary use may be made of arsenic without injury, provided it be thoroughly washed out in the following stages. A direct prohibition of the use of arsenic might therefore not be desirable as regards dyeing.

There is high authority for saying that, as Scheele's green and other arsenical pigments are not now produced on cloth by first-class calico printers, arsenic is not a necessary compound of any pigment or dye used by them, unless it be in the aniline colors; these colors, however, if properly prepared, ought not to contain arsenic in their final condition, or, if they do, it should only occur as a mere trace. English manufacturers generally extract the arsenic entirely, it being essential to the process that they do so, but foreign manufacturers adopt a different and not so efficient a process.

Large quantities of arsenic are undoubtedly used in the production of magenta, which is the foundation of all other aniline dyes, but this arsenic ought to be abstracted in the subsequent processes, and it is so abstracted by first-class manufacturers; how far it is left in, in consequence of inferior manipulation, in some dye works, it is difficult to say. No aniline dye tested for the purpose of this paper has been found to contain arsenic, though several samples have been examined which have produced violent irritation in the hands and feet. There seems, therefore, no reason why arsenic should not be eliminated from all dyed goods and from all cotton prints, as finally sent out for the use of the public. A sample of a stocking which has produced very serious irritation, was received from Dr. Routh, and forwarded to Dr. Alfred Taylor. His remarks are as follows:

"I find no arsenic in the inclosed sample. I believe the coloring is due to a mixture of coal tar dyes, all of which are more or less irritating to the skin, more especially to an irritable skin. This is obviously a bad and unsafe dye, for the color is not properly fixed by any mordant in the stuff. The cutaneous perspiration would suffice to draw it out, as water easily dissolves it."

The bright green arsenite of copper is a favorite color for the cardboard boxes, now so generally used, and for labels of all kinds. Though these boxes and labels are not intended to be eaten, nevertheless, after the case of the death of a child at Peckham from sucking a piece of arsenical wall paper, it seems undesirable to have such a poison scattered widely in our houses, no real object being gained thereby. It is reported by Dr. Wallace, of Glasgow, that on the back

of a single pack of playing cards there was found no less than 83 grains of arsenious acid. This poison, as Dr. Wallace suggests, is liable to be carried to the mouth by uneducated persons who wet their thumbs to deal.

The impropriety of coloring confectionery and sweets with poisonous pigments needs no comment; nevertheless, it is to be feared that there is still a necessity for its prohibition, more especially as regards aniline colors which may be arsenical, and which, if not arsenical, are, nevertheless, not desirable to be eaten. A case of a number of children being poisoned, and having a very narrow escape of their lives, is reported by Dr. Russell, of Glasgow, as having occurred in October last. Some toy sweety watches were made with a ring of sugar, and a paper back of Scheele's green. A single piece of paper contained 0·18 grain of arsenic; the arsenical pigment was, more or less, eaten with the sugar. In fact, an hour or two among the cheaper sweety shops, and the expenditure of a few shillings, would secure a large number of samples dangerous to children.

The reports of injury from arsenical paper collars are so numerous from America, from Germany, and in England, that it seems reasonable to suppose there is some truth in these statements; but, hitherto, there has been no result in the search for definite facts, vouched for by responsible parties, nor have any samples tested for the purpose of this paper proved arsenical. It is very undesirable that needless prejudice should be raised against these useful articles. At the same time, if some are arsenical and injurious, the makers ought to be known.

In the *Scientific American* of March 1, 1879, there is a detailed report of the death of a young lady from the use of arsenical starch, but this, like the arsenical paper collars, does not appear to be confirmed by any experience in this country.

Size is used by paper stainers, also by builders, in the preparation of walls for papering. One correspondent states that he has met with arsenic as an antiseptic in size used for these purposes. Another has found it in large quantities in size used for stiffening veils, tulle, and other articles of millinery. Fortunately, this most dangerous use of arsenic as an antiseptic in size is not general, only these two instances having been met with.

As a sample of the objectionable use of size, it may be well to draw attention to tapestry carpets, which are imitation Brussels, the wool surface of which is so superficial and so slightly secured in weaving as to require size at the back to keep it in place and to give substance or body to the fabric. The size in these carpets is often most offensive, the bad smell lasting as long as the carpet. Drains, etc., are suspected, when the mischief is really in the carpet.

The production of arsenic in this country is on a scale that will surprise most people; when it is borne in mind that two to three grains will destroy the life of a healthy man, an output of 4,809 tons, value £30,420, in one year, does indeed seem a large quantity to be dealt with. This quantity of arsenic is produced from twenty mines in Cornwall and Devonshire; it is an ingredient of copper and tin ores, and has to be separated from the metals in the process of smelting. The arsenic sublimed in the furnaces is deposited in a crystalline form in long galleries through which the fumes are made to pass. The crude arsenic thus deposited is collected at long intervals, and passed on to the refiners. There are but six firms of refiners; from these information has been sought as to the quantity of arsenic used for color manufacture and for dyeing, but no replies have been received. A reply to the inquiry as to how much of a virulent poison is sent out annually for use in our domestic fabrics was, perhaps, hardly to be looked for. This withholding such information is certainly no ground for complaint; at the same time, it may be gathered that the less the public know about this matter the better for the trade.

As the arsenic must be separated from the metal, the expense of collection probably is small, and the bulk of the £30,420 per annum may be looked upon as profit.

Large quantities of arsenic are used for sheepwash, for poisoning seed grain, in the manufacture of glass, for killing vermin, for preserving anatomical specimens, etc., as well as in pigments and dyes; but what the proportions used for the different purposes are, or how the 4,809 tons are distributed, there is no information to show.

This subject, "Our Domestic Poisons," arsenic in particular, has been considered of such importance, that the Medical Society, of London, has thought well to appoint a special committee to investigate the subject, with a view to bringing the matter under the consideration of the Local Government Board. A paper has already been read before that society, on the medical view of the question, by Mr. Jabez Hogg, M.R.C.S.

With a view to the investigation of the action of arsenical fabrics, experiments have been made to test the presence of arsenic in air exposed to arsenical papers. Mr. Phillips, in the second report of the Commissioners of Inland Revenue, 1858, gives the result of his attempts. He failed to detect arsenic in gaseous combination, and goes on to say: "It is probable that persons have been affected by inhabiting rooms papered with arsenical hangings, not because the arsenious acid has been volatilized, but from minute particles of arsenite of copper dispersed in the air;" thus upholding the dust as against the gaseous theory. Dr. Alfred Taylor also considers the arsenical dust as the principal cause of mischief, though in some cases arseniureted hydrogen might be evolved.

Professor Abel made experiments on the presence of arsenic in gaseous combination, but failed to discover it.

Dr. Fleck, of Dresden, did obtain arseniureted hydrogen from a wall paper and paste in the experiments he carried out. Professors Roscoe and Schorlemmer also obtained arseniureted hydrogen from an arsenical wall paper and paste, at the same time, however, they attributed injurious effects to dust as well as gas.

Professor Bamberg, of Stockholm,* observes that "the injurious effects of arsenical pigments, as applied to the walls of apartments, have been observed by physicians in almost every civilized country." He made a very important and successful experiment himself, detecting arsenic in a gaseous form in the atmosphere of a room that had been papered for 25 or 30 years.

The following is from a manufacturer of wall papers:

"It appears to me that the 'dust' theory is much more tenable generally than the 'gaseous,' and much more likely to be the cause of mischief. This was especially noticeable in the case of our own men when we used arsenical colors. The printers who work on several thicknesses of felt, called blankets, which become charged with dust, were much more affected than other workmen, having charge of different processes where the dust did not so much accumulate. Bearing this theory in mind, it is also to be remarked that the greater number of cases of arsenical wall paper poisoning of late years may reasonably be attributed to the more extended use of machine papers, in which the colors are notably less firmly fixed by the sizing material than in the older block-printed papers."

That arsenical dust is productive of serious injury, there can be no doubt, and, in certain cases, it is clearly proved that some volatile compound is given off; but whether the injurious effects arise from dust or gas, the public look to be protected from a poison, the results of which they know well by experience, though they may know nothing of its mode of action.

The information gathered whilst pursuing this subject leads to the following conclusion:

That many persons suffer in an extreme degree from exposure to arsenical fabrics—not a few to the extent of loss of life. That, judging from the number of cases brought under notice in a private circle of friends and acquaintances during this investigation, there can be no doubt that great injury to health is produced in a vast number of persons throughout the country. There is every reason to believe that a serious amount of deterioration of the constitution is going on all around, though each individual case might not appear severe; this remark will apply more especially to children.

Great irritation is also frequently produced by articles of dress dyed with aniline colors being brought into contact with the skin. These aniline dyes produce this irritation when free from arsenic, though the injurious effect would be increased by arsenic being present also. The irritating effect of aniline dyes probably arises from unskillful management in the process of dyeing, the free dye being insufficiently washed out.

The remedy suggested would be a law prohibiting the use of arsenic in the manufacture of all fabrics for domestic use, that is, in all those processes which leave the arsenic in the finished goods. The laws of France and Germany might be taken as a guide. The retail vender to be liable to punishment, whether ill effects be produced or not. Such liability, however, might in many cases fall unfairly and unjustly on a retail vender who had taken all reasonable care to avoid arsenical articles; it is, therefore, further suggested that facilities should be given to enable the retail dealer to throw the responsibility on to the wholesale manufacturer; as, for instance, with regard to paper hangings, the color maker is the real culprit, but the public have no means whatever of getting at him. If, however, the retail dealer be made responsible in the first instance, and facilities be given him, enabling him to throw the blame on the paper stainer, and the paper stainer again on the color manufacturer, each offender being only allowed to escape on his substituting another, the real culprit would be reached. Otherwise, the manufacturer of arsenical colors would practically be safe from liability. It would be the paper stainer's duty to note his purchases of color, so as to be able to trace them, otherwise the responsibility would rest with himself.

Finally, it is maintained that the whole subject of "Our Domestic Poisons" is a matter of such importance as to demand Government investigation.

DISCUSSION.

Mr. Jabez Hogg, M.R.C.S., having given some attention to this subject, could confirm a great deal of what had been said. A committee of the Medical Society of London, of which he was a member, was now sitting and considering the subject on the lines pointed out by the Chairman. That committee had sent out a number of inquiries, but at present the information received was not full enough to enable them fairly to bring it before the Government, but they were getting further answers every day. They were met by certain difficulties, one being that the question was so new, even to medical men, that many of them were not prepared to give an opinion. Their patients suffered from the symptoms which had been described, but these were so identical with the symptoms of a number of other diseases that medical men often failed to separate them. Mr. Spitta, whose name was mentioned in the paper, was, a few years ago, a disbeliever in arsenical poisoning, and only became convinced of its existence on having his attention specially directed to the subject. But the number of cases which were now authenticated were truly marvelous, and they were vouched for by men of position, whose powers of observation were undeniable. There was the case of Professor Reynolds, of Owens College, Manchester, who, having had his study freshly papered, suffered from these remarkable symptoms, which always subsided when he left the room for a few hours, and disappeared with a day's holiday in the country. This excited his attention. He discovered that the paper of his study was highly arsenical, and on removing it he was enabled to carry on his work with comfort, whereas, before, he suffered so much that he feared he should have to abandon it altogether. There were two or three points with regard to the manufacturers themselves. No doubt many of them were earnestly desirous of avoiding any further injury to the public, and would be willing to promote any legislation which was deemed advisable; but many of those who used these arsenical pigments were not aware of the fact. For instance, in some of the aniline dyes, a dangerous contamination of arsenic was left in; and only last week he read an account in a French journal of three cases of poisoning by hydrochlorate of aniline used by a surgeon externally. On suspecting the cause of the evil, he injected some of the aniline into the veins of a dog, and produced violent effects of poisoning. Lead again produced very serious effects, and these were sometimes observed after sleeping one night in a room newly painted. Medical men were unable to account in any satisfactory way for its fearful effects in producing paralysis. This led to the question of how the poisoning was produced; which was a most difficult question to answer. There was, however, the unmistakable clinical fact that the poisoning did take place with many individuals, some being much more susceptible than others. Whether it was the effect of some gaseous emanation or of dust, was not of so much consequence as the fact of its occurrence, and that medical men had hitherto seen these cases without suspecting the real cause. His own opinion, seeing that much more serious effects followed than were produced by administering arsenic internally, was that there must be something more than the mere irritation of the mucous membrane which the dust would cause. In one case a gentleman went down to Osborne, slept in a room which had been newly papered, and the poisonous symptoms were so marked that he immediately swooned away and remained in that condition all night. The next morning he was aroused with difficulty by the servant, and on staring round him and seeing the bright green paper on the walls, ejaculated, "Poison, poison!" much to the horror of the servant, who thought she was accused of poisoning him. He managed to put on his dressing gown, and to leave the room when the whole of his symptoms vanished as if by magic. Cases of that kind were so remarkable that he thought something more than the dust must be concerned, and that there must be some gaseous product which chemists could not separate. He must confess, however, that the experiments made by Mr. Phillips were not of a very satisfactory character. You could not test arsenic in the air in a laboratory under the same conditions as when a room was papered with a poisonous substance; and some eminent men were of opinion that there was arseniureted hydrogen evolved which affected some people strongly in a very short time. The final question was whether some restriction should be placed on the sale of arsenical pigments, and he thought it would be very well if the Society of Arts, in connection with the Medical Society, were to make some representation to the Government. There was an Act to prevent the sale of poisons which said that no arsenic should be sent out in retail quantities unless colored with charcoal properly labeled, and in the presence of a second witness; but, while this Act applied to the sale of small quantities of poison, it said nothing about the wholesale dealing in this material. You could buy a hundredweight, and employ it how you liked; and, therefore, you could drive through the Act with greatest possible ease. That was an anomaly which he thought the Government should take into its consideration, especially as it was evident that good colors could be prepared without arsenic.

Dr. Bartlett said he would mention some of the more important points which came before him in the case Mr. Carr had alluded to. That was an instance in which they could trace the effect of arsenical and other poisons worked out to the final issue. He was ordered by the Home Secretary to investigate the character of certain dyes, and in that case a girl died who had been at work for six weeks engaged in dusting these colors on varnished tin plates. He believed her employers were ignorant of the dangerous business they were carrying on, for they, themselves, furnished him with the materials for analysis, among them all those enumerated in the paper and some others. As showing the doubts which existed in the medical mind on this subject, he might mention that the district medical officer reported that he could find nothing more than a very slight amount of inflammation of the stomach; and he was not aware whether he had preserved the contents of the stomach for analysis. As a matter of fact, the coroner's officer had done so, but as he mentioned at the time, that was exactly where he did not expect to find poison in any quantity. From his inspection of the factory he found there was an enormous quantity of arsenical dust present in the air, the girls being positively covered with it, and if the medical man in charge of the case had had any knowledge of the way in which arsenical poisoning affected the patient, he would scarcely have given an opinion in the first instance that he could not account for the cause of death. There was diarrhœa, with a condition of the bowels which even the coroner observed was not in any way consistent with an ordinary attack of that malady. The girl went to the factory in moderately good health, and died in six weeks. The inquest was adjourned from time to time, and in the end, after he had proved that there were tons of poisonous pigments on the premises, and when he showed that another girl, who was brought forward as a specimen of perfect health, had symptoms of lead poisoning, the jury said there was not sufficient evidence to show by what cause the girl had come by her death. This showed that medical men were not sufficiently aware of the symptoms produced by these poisons; and if that was so in their case, how much more so in the case of the general public. Mr. Carr had done good service in bringing this subject forward, and perhaps more so in bringing it before the public than before medical men. A large number of cases of illness from wall papers had come under his notice, and there was no doubt there was an idiosyncrasy which was prone to take this poison in the same way as others were liable to poisoning by antimony or by ipecacuanha. Where one might pass with impunity, another would suffer to the greatest extent. He was afraid that our manufacturers, if they wished to give up the use of arsenical colors, would be at a great disadvantage. Foreigners manufactured arsenical colors which they imported into this country, though they were not allowed to use them in their own. He stated this fact from knowledge obtained while engaged in the inquiry he had referred to. Enormous quantities of colors which could not be used in Germany or Russia were brought here. There was no stoppage at the Customs, nothing to prevent them being sold in wholesale quantities; so long as you did not sell pennyworths, you might sell as many cwts. as you could get customers for. If a wall paper manufacturer had not chemical knowledge, or did not submit every sample to a competent chemist, he might be disseminating these poisons with the most innocent intentions in the world; and in many instances he believed those who had so innocently pushed forward these papers had had their business injured by persons writing to the newspapers, saying they had bought of so-and-so papers guaranteed not to contain arsenic, which, on being tested, were found to be contaminated with it. It was not a question of green only; any other color might contain it. He would not go into the question of aniline colors, but he thought all poisonous colors came under the same category. If a man ordered his room to be papered, and said he would not have an arsenical paper, and afterwards suffered from the symptoms which had been described, and had to send for a medical man, and incur expense, probably a lawyer would say that he had his remedy. Was he to apply to the man who hung the paper? and if so, would he have his remedy against the manufacturer? and then, again, could the manufacturer transfer the liability to the color maker in Germany who could not be got at all? The question was, should the poisonous pigments be allowed to pass the Customs? The Medical Society had taken up the question, so had the Society of Arts, and he should have much pleasure in bringing it before the Sanitary Institute, for he thought all societies which could exercise any influence ought to help in a matter of this kind.

Mr. Hale was surprised to learn that the use of arsenic was not confined to a few colors, and suggested that all wall papers should be inspected before sale.

Dr. Thudichum said Mr. Carr's endeavors had his sympathy, for the matter had occupied his attention for a long time, as it had that of other toxicologists and chemists. But on looking round the room he found his sympathies somewhat distracted. His eyes rejoiced at the beautiful bright arsenical paper, and when he looked at the abominable grays, hideous browns, and dreadful yellows, made without arsenic, he could not help thinking that that would be the paper he should like to have in his room. Then came the

* The *Pharmaceutical Journal*, August 1, 1874, where a very full description of this experiment will be found.

question what that paper was. Arsenical, no doubt, but there was something else which was poisonous, viz., copper. If those papers were so poisonous as was reported, so that a man sleeping in a room with them for one night was affected as had been described, why was it all put down to the arsenic? Why was there never any symptom of poisoning by copper? He happened once to be at Marlborough Street Police Court, when a number of poor shopkeepers were prosecuted for selling green vegetables in tins made in France, the same brands as he had eaten of himself for twenty years. There was a long array of chemical evidence, portraying the dreadful symptoms of poisoning by copper, all as they were described in books, but he doubted if any one had seen the symptoms in this country; and the shopkeepers were all fined for having poisoned the public with copper in the green peas. Why did not these evil results follow the use of this bright blue paper?

Dr. Bartlett said he had analyzed the paper referred to, and it had no copper in it.

Dr. Thudichum said in that case it was a mystery he could not penetrate, because all Schweinfurth green or blue was arseniate of copper, and that was the pigment generally used in these papers. Arsenic had no business in a paper, except either as sulphide of arsenic as in burnt sienna, or as arseniate of copper as in the blue paper. In the other colors it was only present accidentally; for instance, in the so-called aniline dyes, it was a mere delusion. There ought to be none left in, and if it were it would be removed by a good washing. If arseniate of copper were put out of the question, the rest of the arsenic would not be worth talking about. Another point was the connection of the symptoms alleged to have been produced by the dust from the arsenical papers with the alleged cause; and there, he thought, all symptomology almost came to an end. The only actual point bearing on this had been made by Dr. Bartlett, who had found arsenic in the case of the girl who died from its effects. That should be done in every case. Where it was alleged that a person suffered from arsenical poisoning, it was necessary that arsenic should be found in the excreta at the time, for, unless that were done, he did not think the poisoning by arsenic was proved. Unless you had scientific proof that arsenic had caused the mischief, the allegations would always be intangible, and could be traversed by simply saying that the symptoms were so similar to natural symptoms that they could not be distinguished from them with certainty.

Mr. W. Botly thought they were much indebted to Mr. Carr, and, as a layman, he could corroborate what he had said. The son of a neighbor of his become very ill, having all the symptoms which had been described, and the doctor at last, being unable to account for it, examined his bedroom, and finding a green paper on the walls, ordered him to leave the room, when he soon recovered, and the paper being taken down, he was quite restored to health. He was recently told by a manufacturer of arsenic in Devonshire, that he had taken an order for four tons, merely for the manufacture of dolls' eyes. It was astonishing how much was used, and in how many different ways. He should like to ask whether these papers which were so deleterious might not, by glazing or varnishing, be rendered innocuous.

Dr. A. Swaine Taylor, F.R.S., said he could express a general concurrence in what had been stated on this subject. One point which had not been noticed was, that arsenic was found in the urine of those who had suffered from sleeping in rooms with arsenical papers. Taking this together with the fact that the symptoms disappeared on changing the room, showed conclusively that the result must depend on the action of arsenic. He could quite confirm what Dr. Bartlett had stated, that all persons did not suffer alike. It was the same with lead and other poisons, some were easily affected, and others were not. When the late Louis Philippe was at Claremont, there was a case of lead poisoning through the water supply, but though the king and princes all suffered, the total number, out of a household of about 34, who were affected was only 13 or 14. There was nothing advanced in the paper but what had been proved by experience.

Dr. Lauder Brunton, F.R.S., said he would first deal with the question whether it had been proved that the community suffered by the use of arsenical papers. As Mr. Carr had said, it was very hard for one who had not paid attention to the subject to believe that such minute quantities as could be given off were capable of producing any harm, and perhaps it was even harder for a medical man than for one of the general public, because he was in the habit of prescribing arsenic without producing any ill effects, but, on the contrary, doing great good to his patients, and this in much larger quantities than could be given off from a wall paper. In fact, when he read a circular about two years ago on this subject, he threw it at once in the waste basket, because he did not think there could be anything in it. A few months afterwards, however, he had to change his opinion entirely. He put up a paper in his sitting room, which he had the assurance of the manufacturer that it was free from arsenic as he thought it as well to be safe. He was constantly in the room, and shortly began to suffer from symptoms so markedly those of arsenical poisoning that he went to the man who sold him the paper, and asked if there could be any in it. He said no, every paper they sold was free from arsenic, but as his symptoms continued, he had the paper analyzed, and found it was loaded with arsenic. A great number of medical men were blinded like himself by the fact that they gave considerable quantities of arsenic by the mouth without doing any harm. An instance of this was that of a medical man in the north of London, whose wife suffered from constant intestinal irritation; but he never suspected arsenic until the paper of the room was removed when the symptoms at once ceased. He then suspected there was arsenic in the paper, which he believed was afterwards confirmed by an analysis. So much arsenic was used that it was quite evident that all persons were not equally susceptible to its effects; and those who did suffer from it in this way were not injuriously affected by it when taken medicinally. He himself was an example of this. Arsenic was a favorite remedy in ague and intermittent fever, where quinine did not seem to suit, and having once taken ague in Italy, he still occasionally suffered from malarious symptoms, and had been benefited by arsenic in medicinal doses, and had, no doubt, swallowed much more than was given off from the paper, though the latter produced ill effects in less than 48 hours. This greatly increased the difficulty of collecting evidence as to the number of persons suffering from arsenical poisoning. Still, quite sufficient evidence had been obtained to show that disease was caused in numbers of cases by wall papers, and there could be little doubt that there was necessity for legislation. In his own case he had put up the paper at a considerable expense; he suffered a good deal, and lost a great deal of time on account of the great lassitude which followed, which seemed to be one of the most marked symptoms. When he went to the man who supplied him the paper, and told him the paper contained arsenic, he said he would communicate with the manufacturer, but all the satisfaction he got was a reply that arsenic was much more widely distributed in the mineral kingdom than medical men had any idea of. All the public were in the same condition. Some persons might not object to arsenical poisons, or might not be liable to it, but it was very hard that those who did not care to run the risk should be forced to do so unwittingly, and that when they did suffer they had no redress. For his own part, he was much disinclined to interfere with freedom of trade. If any one wished to manufacture arsenical paper let him do so, and if any one wished to buy it, either because it was pretty or cheap, by all means let him do so; but it was very hard that those who did not want it should buy it under a guarantee, and then find they had arsenical paper after all and have no redress. If a person bought coffee containing chiccory, he could prosecute the seller unless it were labeled as a mixture, and the same simple remedy ought to be applied in this case. He would simply pass an Act rendering it penal to sell an arsenical paper without the fact being clearly stated upon it: "This paper contains arsenic." That would not prevent the manufacture or importation of arsenical colors, and paper stainers could protect themselves by employing a chemist to analyze the colors before they bought them. This would meet the evil to a very great extent if not entirely.

Dr. Bartlett said it must be printed on the front of the paper, or else it would not be visible after the paper was put up.

Mr. Aumonier, as a practical paper stainer, wished to know if Mr. Carr had tested the black separately in the two samples he had referred to; if not, the arsenic would probably be due to the brown.

Mr. Carr said it was tested as a whole.

Mr. Aumonier could confirm Dr. Bartlett's statement, that the bright blue paper was perfectly free from copper. It was a color of which he had never yet been able to get a specimen free from arsenic; but within the last week he had seen a sample very nearly as bright, quite free from arsenic of foreign make. And here he would say a word to English color manufacturers, to induce them to make some effort to produce bright colors free from arsenic. More than half the money he paid for colors went to France and Germany, because he could not get in England the same brilliancy of tint. Wherever there was arsenic, it was in the pigment and not in the paper or the size, and it mainly came from emerald green. The red colors which contained arsenic were probably magenta, and the arsenic was due simply to imperfect purification. The factory with which he was connected had discontinued the use of arsenical colors for some years, not from the belief that they were likely to cause much mischief, but partly because there was a general feeling on the part of the public against them, and they found it was quite practicable to get such tints as they wanted free from it. He thought if it were made penal to sell a color arsenical in nature without making the fact known, it would soon put a stop to the use of them in paper hangings; but he did not believe that in many cases paper stainers were aware of the presence of arsenic. Unless they went to the expense of having them tested in every case, they were not likely to become acquainted with the fact, because it was impossible to tell by merely looking at the color, or by anything which appeared on the face of it, whether it were arsenical or not. He was rather surprised that Mr. Carr had not alluded to children's toys, on which a large quantity of emerald green was frequently used and might lead to great mischief.

Mr. Carr said the two specimens of dark color to which he had referred came from the same pattern book, and were supplied from the same firm, but it was possible they were not the same manufacture. With regard to the question of varnishing or glazing these arsenical papers, if the evil arose from the dust it would appear to be a remedy, but if it arose from noxious emanations it probably would not. He did not see how the question could satisfactorily be decided, as persons would naturally object to being experimented upon.

[Continued from SUPPLEMENT No. 219, page 3494.]

PNEUMONIA.

Two lectures delivered at the College of Physicians and Surgeons, New York, by ALONZO CLARK, M.D., LL.D., Professor of Pathology and Practice of Medicine.

SOME time ago I gave you an account of fibrinous bronchitis. It is not an uncommon thing that a fibrous bronchitis complicates pneumonia. You will frequently, on cutting into the lung—that is, the seat of this disease—draw out from the bronchial tubes little threads looking like grayish-white worms. They are always, I believe, casts of the bronchial tubes, coming from a bronchitis which has complicated the pneumonia. And here I may say that a severe bronchitis with a pneumonia makes the disease a great deal more dangerous. I made some investigations into this matter a few years ago. I applied to the registrar of the board of health for information in regard to the prevalence of the united diseases, and he sent me a page of statistics that confirmed my idea, that when pneumonia and bronchitis occur together, and the latter is severe, the case is much more dangerous than when pneumonia occurs by itself.

The progress of this disease is such that you may expect no additional inflammation after the completion of the fifth day. It is true that in some instances, by involving new portions of the lung, the disease may advance after that time, but generally the end of the fifth day limits its progress in the structure of the lung, and you have remaining the consequence of what has occurred. It is not uncommon to find some subsidence of the pulse on the sixth day, but not until the ninth. In feeble and in aged persons it sometimes happens that pneumonia does not notice the ninth day for the beginning of its resolution. It may continue for four weeks, giving the physical signs, the patient remaining pretty sick, and still he may recover. But if it does not resolve at that time, there is reason to fear that it may be converted into one of the forms of phthisis, pneumonic phthisis or inflammatory phthisis, as it is sometimes called. The lung being infiltrated with the products of the inflammation breaks down—not the plugs alone, but the structure of the lung also, and forms cavities, and these will go on to the destruction of that portion of the lung that has become so infiltrated, and probably to the destruction of the life of the patient. This we used to call an infiltration of tuberculous matter, but I think we were in error. It seems to be unresolved pneumonia. With, then, this history, it is pretty easy to recognize pneumonia, either early or late, and commonly it can be recognized at once.

It affects persons differently at different times of life. Like bronchitis, it is very grave in infancy and, again, in advanced age. For example, in 1878 the number of deaths in New York from pneumonia was 2,288, in a general mortality of 27,000 so that about one in fourteen of all the deaths was caused by pneumonia. Of these, under one year, there were 590; between one and two years, 379; between two and three years, 188; between three and four years, 80; between four and five years, 47. Observe how strong the contrast between the first year of life and the four following years—590 in the first year, 47 in the fifth. Then coming to a more advanced age, from five years to ten, there were 74; from ten to twenty there were 41. From ten to twenty, then, pneumonia is of rare occurrence. From twenty to thirty the deaths were 116; from thirty to forty, 161 (observe it is increasing); from forty to fifty, 178; from fifty to sixty it falls off just six, 172; from sixty to seventy, 153; over seventy years, 159. Death from pneumonia occurs a little oftener in males than in females. Of the 2,288 deaths in New York last year, 1,204 were males, and 1,084 in females. Considering the number of persons alive after seventy, and that the mortality of that class is 159, it makes pneumonia a severe disease in old age, and, as you have noticed, a very severe one in the first year of life, 590 deaths.

In regard to the causes of pneumonia, we say in general that cold produces it, and that is about all we know. Why cold, affecting a hundred persons in the same way, would produce pneumonia in only one of them, is a problem that has not yet been solved. But the relation to the season of the year is somewhat understood. Of the number of deaths in this city, caused by pneumonia, in 1876, the greatest number occurred in March, the least number in August. The deaths from this disease during the several months of that year were as follows. For January, 255; for February, 321; for March, 376; for April, 282; for May, 241; for June, 149—(almost a hundred less than the previous month)—for July, 114; for August, 105; (now the number begins to increase,) for September, 118; for October, 156; for November, 195; for December, 236.

There is, undoubtedly, then, some relation of the weather, some relation of the cold season, to the production of pneumonia. It does not abate, however, in the summer season, but diminishes to less than one-third the maximum mortality.

In regard to the appearance of the lung, you will get a tolerably good idea of the color and appearance of gray hepatization from the figure which I show you. Occasionally the transition from the red to the gray hepatization can be marked, and Cruveilhier has here given that precise moment when this can be best represented, but without knowing its significance.

With reference to the treatment of pneumonia, it will vary of course with the general condition of the patient. If it occurs in the course of other diseases it probably will not admit of much treatment, but occurring by itself, alone, it does not seem to yield in a certain degree to what we can do for it. I have not myself lost a fondness for the lancet in pneumonia. It is very unfashionable to talk of lancets. A few years ago I received a patient in Bellevue Hospital, a young woman, who had been entirely healthy before this pneumonia set in. After inquiring into her habits, and learning that she did not drink, that she was of "steady habits," I told the house physician he might bleed her. He said he could not, for he hadn't a lancet, and from among the fifteen or twenty doctors present not a lancet could be borrowed. I then sent him to the surgical case to get one, that being the only way to get a lancet for this particular occasion. We bled her about twelve ounces, and she did very well. In bleeding I have been much accustomed to use cups after scarification, taking three, four, or five ounces from the affected side. I do not suppose it makes much difference whether you bleed from the affected side or from some other part, but it is the fashion so to take it in the hope that it may do more good. It was the fashion when I entered the profession to ptyalize, as soon as possible, in the idea that that condition of the system diminished the plasticity of the blood, and left the patient to an easier recovery. The practice and the reason for it have both been abandoned. We do not hear of anybody giving calomel now with a view of producing ptyalism in pneumonia. In Laennec's time the treatment that he was most attached to was the administration of tartar emetic in such quantities as to reduce the force and frequency of the pulse. He began giving it with the intention of producing a tolerance of the drug, gradually increasing the dose until he often reached six grains, and it would be retained in the system without producing vomiting. He announced everywhere that that treatment was more successful than any that he had ever tried. But it was found from examining his books after his death, that he had not had any greater success after adopting this plan than he had had before. Like the late Dr. ——, of Philadelphia, he forgot the unfavorable cases and remembered the favorable ones. The tartar emetic treatment, I believe, has been mostly abandoned. Of late years it has become the fashion to do but little for pneumonia as such, but to treat the symptoms. For example, when the temperature rises to 105°, and especially if it rises to 106°, to give some medicine that will reduce it, or to make some application that will produce the same result. For my own part I am satisfied that the safest thing is quinine. Ten grains to an adult three times a day will almost always bring the temperature down several degrees when it is up to 106°. It must be given in full doses, however. The application of cold to the surface of the body is, in some instances, I am satisfied, disastrous. For example, when I entered upon my hospital service, on a certain day in the spring, I found six cases of pneumonia in my department under treatment by the application of ice to the chest. I had read of that treatment among the Germans, and I confessed to a little interest to know what it would do. I allowed the treatment to be continued, and four of those six men died. I have not since allowed any ice to be applied to the chest of a patient of mine who had pneumonia. Sponging with cold water is admissible, and a bath at a temperature twenty degrees below that of the body is admissible. At the same time quinine seems to have about all the power of the bath, or other external applications, and I am rather attached to it. It will, with a good deal of certainty, reduce the temperature, but it will not cut short the pneumonia. It will not modify materially the progress of the inflammation, but as the fever is exhausting, if you can reduce that you have gained a point, and you have increased the chances of your patient's recovery. Understand that the pneumonia will run right on its natural course, undergo its natural resolution, if the patient gets well, unaffected by the quinine. Veratrum viride will reduce the temperature of the body. The objection to it is, that when given with any freedom it is very apt to lead to

collapse. I have never seen that collapse fatal, but have met it frequently enough to be afraid of it. Aconite has somewhat the same power, less energetic than the veratrum viride, and therefore safer, and it is the habit among physicians to give the tincture pretty freely with a view of reducing the frequency of the pulse and the heat of the body. In one particular case of pneumonia the use of calomel was well exhibited. During the life of the late Dr. Cammann, a gentleman boarding in one of the down-town hotels had pneumonia, and the physician called me to assist him in the treatment. We called on him for two or three days, and it seemed that he must die. His friends asked that Dr. Cammann be added to the consultation; he came, and proposed the administration of large doses of calomel. Three doses of a drachm each were given in the course of a day, and three or four doses from a scruple afterward, and the man recovered of his pneumonia, but lost every tooth in his head. But the dentist supplied him with new ones, and he thought life was worth having even with false teeth. I no not believe he would have recovered but for that calomel, and yet calomel given in this manner has not become a favorite treatment of pneumonia with me, on account of its disastrous effects on the teeth.

Pneumonia is somewhat more likely to occur in a person who has had it than in a person who has not. I do not know whether it is because of a constitutional liability, or whether it is that once having it renders a person more susceptible to it in some unknown way. It is not very often, however, that a person having once had pneumonia has it again; only often enough to enable us to say that the liability is somewhat greater in those than in others.

An interesting fact that I have already stated is, that after a patient recovers from pneumonia there are no lesions, no effects left. The vessels are fully restored to their function, the air cells are repaved with epithelium, and the lung performs its office as well as it did before. It is true that the pleurisy may cause adhesion of the lung to the chest wall, and produce some contraction of the chest. There is a form of pneumonia that deserves to be spoken of apart, and particularly because it lacks the alarm bell that is rung at the beginning of an ordinary form of the disease, namely the chill. For example, a man has an operation for the removal of stone performed upon him, and after the operation for two, three, or four days, during which time he has been doing pretty well, he begins to grow worse; he has a little cough; he has perhaps a little pain in the side; his respiration becomes more frequent, but, as is the case in open pneumonia, it is not difficult; no dyspnœa, but the breathing is frequent and shallow. Perhaps you may detect some of the characteristic expectoration. He has a pneumonia which he would not have had if the operation had not been performed upon him, and this kind of pneumonia is to be regarded as one of the risks attending surgical operations, a secondary pneumonia. I say the patient has no chill; he has, perhaps, pain in the side, and perhaps not; he has the characteristic expectoration. You listen to his chest and find the breathing of pneumonia; you find the crepitant rales, and dullness on percussion, and it is altogether likely, do what you will for such a person, he will die. Now there is no chance for taking blood by cups or leeches, but you have to sustain your patient by tonics, and perhaps by alcoholic stimulants, from the beginning, carrying him through if you can.

Regarding the alcoholics in the treatment of common pneumonia, I think they are utterly useless. If a man has obstruction to the breathing organs to such an extent that it threatens to destroy him, the alcohols will not cause a removal of it, and though he may breathe a few times more on taking them it will not amount to enough to enable him to recover. You will be tempted to give alcohol in all cases of pneumonia, but you will come to this conclusion, if you have an experience similar to mine.

There is another form of pneumonia that I must refer to. It is sometimes denominated broncho-pneumonia. It is a little characteristic. It affects certain lobules of a lung; it occurs in spots; it does not run over the whole lung and become general, but here and there a little group of lobules becomes the seat of inflammation, then another group, and another, until there may be sixty, or a hundred of them in one lung. They are generally superficial, or most noticeable, at any rate, upon the surface. There will be a spot of red surrounded by the natural gray color of the lung—a spot from little more than a point up to the size of the end of my little finger, or it may be even larger than that. This is a regular pneumonia, but confined to spots. At Bellevue Hospital, the other day, some of you had an opportunity of seeing a specimen of that kind of pneumonia—little islands of inflammation surrounded by comparatively healthy lung.

I shall have occasion to say something about chronic pneumonia in the course of the hour, and I will not wait for the subject to come in before I show you some specimens of lung that has undergone the changes of that disease. (The plate of sections was then passed around among the students.) On another plate are a few injections made by the late Dr. Cammann, showing that the circulation in the lungs is not a very open communication, but that when a vessel is located near the periphery of the lung, and the injection made into it, it goes to a limited portion of lung; that the vessels divide, to be sure, but each particular vessel divides to supply only a given set of lobules, or perhaps even one single lobule. There is no anastomosis between the different lobules of the lung. A lobule is made by an aggregation of air cells, each lobule having its air tube and its vessel, and that vessel ramifies upon each particular air cell so as to make a complete network of capillaries on the outside of its walls. The size of the lobules you can get an idea of by a reference to this figure. This, then, will show you the limitation of injections thrown into the smaller vessels. Each lobule is, as it were, a single, minute lung, having no communication with other lobules except through the vessels that are behind, toward the heart.

I now call your attention to broncho-pneumonia. I had begun to speak of it in my last lecture. It is a form of disease that occurs almost exclusively in young persons. To be sure we saw a specimen of it the other day at the hospital that was in a person forty years of age who had been reduced by previous disease; the liver had been long affected; she was in the habit of drinking, and in general was badly broken up, and she took pneumonia. It was partly of the character of general pneumonia, and partly lobular. You remember the little spots of inflammation surrounded by healthy lung. That is substantially a lobular inflammation. Lobular inflammation occurs always with catarrh, and not unfrequently with suffocative catarrh, and it is difficult, indeed, almost impossible, to assure yourself whether lobular pneumonia exists or not in that condition. This lung which I now show you represents the appearances of lobular pneumonia. You will observe spots of inflammation scattered through both lungs, these spots surrounded by healthy lung. They always occur with capillary bronchitis. I do not mean to say that capillary bronchitis cannot exist without lobular pneumonia, but that it will not exist without the previous existence of capillary bronchitis or suffocative catarrh. Each of these little points of inflammation goes through the same changes that the lobes of the lung do in general pneumonia. There is a congestion, there is a consolidation of these little points, then there is a red hepatization, a gray hepatization, and a resolution if the patient gets well. You may find it in the gray stage; I have frequently. You may find it a little difficult to distinguish its color from that of the lung, but there will be a hardness as you pass your finger over it which marks the extent of the inflammation, and there will be a little elevation of it.

The diagnosis of this lobular inflammation, as I said, is almost impossible. It is true that the temperature of capillary bronchitis does not often exceed 102°, while the temperature of lobular pneumonia may go up to 105°. Then, if a child suffering from capillary bronchitis begins to suffer pain in the chest, and if by its movements it increases that pain, that is a reason for supposing that lobular pneumonia may have become a complication with the capillary bronchitis. The expectoration in children that are mostly liable to capillary bronchitis with lobular pneumonia, you rarely see. It is brought into the mouth and swallowed. It is altogether likely, if it could be examined, that it would indicate pneumonia by some strips of colored material. It is, then, chiefly by the temperature and evidences of pain, that you infer the existence of lobular pneumonia.

As to the treatment of this form of disease, it does not materially differ from the treatment of capillary bronchitis. The warm bath, the oiled-silk jacket, those medicines that will aid perspiration, are the best. A pretty free perspiration is the most curative thing that you can apply in both these diseases.

Very similar in appearance to this, is a condition of the lung that has been called atalectasis. It has an appearance exactly resembling that shown in the plate which you are now examining, that of lobular pneumonia in the red stage. One lobule or several lobules associated will return sometimes to a condition of the lung in the fœtus. You know the lung is all consolidated in the fœtal state, and the act of crying, which every human being that survives, attempts, implies a forced inspiration to open the lungs. That is, the forced inspiration is a part of it, and that opens the lungs for the admission of air. In feeble children, it not infrequently happens that the lung is not fully opened; there remain spots that are still in a state of condensation, or atalectasis. Then, again, in children that are feeble, a little disease (?) occurring within a month perhaps after birth, will so reduce the force of the respiratory muscles that the elastic element of the lung will bring it back into the fœtal state—not the whole of it, but a part; here and there a spot, sometimes a quarter of a lung. This condition is not distinguishable by its color from lobular pneumonia in a state of red hepatization. It is distinguishable, however, by certain appliances which you can make. For example, you pass your finger over a questionable red spot; you will find that it falls away a little from the even surface. Then, again, if you inflate the lung, you can fill out this red spot, which you cannot do if it is the result of inflammatory action. You may produce a rupture of the air cells, or of the intralobular passages, and infiltrate the surrounding tissue with air; but you cannot inflate an air cell that is filled with the products of inflammation. In inflammation during life the temperature will be higher than in a child that is suffering from atalectasis, but we know very little about atalectasis as an ante-mortem affection; we know it chiefly by its appearances after death, resembling then very strikingly in shape and color lobular pneumonia, but differing from it in the particulars that I have named.

It has been said sometimes that gangrene attends a pneumonia, as a consequence. This, I think, is a mistake. There is such a thing as gangrene of the lungs, a condition in which a part of the lung dies and is removed by expectoration, or the patient sinks under the effort. Now, this is, I believe, wholly unconnected with pneumonia; is an affection preceding it, the pneumonia attends it. Gangrene of the lungs always occurs in consequence of an obstruction of one or more of the arteries of the lung. It may be by disease of the artery; it may be by thrombosis; it may be by embolism. An obstruction, and pretty complete obstruction of a considerable branch running to divide for the lobules, as I have already described, is an affection preceding gangrene, causing the lung, or a portion of the lung, to be deprived of blood.

As there is no anastomosis between the vessel which supplies a particular part of it with blood and those in the neighborhood, it cannot receive blood from any other source. Obstruction of an artery, according to its size, will cause destruction of the lung more or less extensive. The process is that of starvation; the supply of blood is cut off by an obstructed vessel, and the portion of lung that should have been supplied with blood by this artery must die if the obstruction is of long duration. I investigated this subject with the late Dr. Sweet, and we agreed in the opinion here expressed. As this is as good a place as any to give a description of gangrene of the lung, I will give it now. You know nothing of the destruction of the artery that has led to gangrene. That goes on silently, and gives no particular symptom. But at length a person who is suffering this way begins to feel uneasy, uncomfortable, ill, and he perhaps yields to the defect in the circulation before there is any decomposition of lung tissue; but that follows quickly, and then he begins to have a fetid breath, the fetor being that of decomposing animal matter. This becomes worse; and at length he has some expectoration of a greenish material, more or less shreddy, in small fragments at first, but growing more and more shreddy and abundant as the disease advances. He has now a fever; the temperature may be very considerably elevated. He is quite prostrated, keeps his bed or perhaps sits in his chair for a portion of the day. This fetor of the breath you do not always perceive except when the patient coughs, but in coughing he fills the air with a most offensive odor. This process of decomposition, or rather of destruction, goes on until all that portion of the lung that was supplied from the obstructed artery has undergone gangrene and has sloughed out. Then, if the patient has strength to endure it, there may be a reparative effort. Indeed, this begins before all the gangrenous portion has been removed. One part of the denuded surface of the lung may be clear of gangrene, and that will begin to get gray instead of a dirty green: and there will form upon it a new membrane, which is partly protective and partly pyogenic, for it has both offices; and as the dead portion of lung sloughs off from point to point, this new membrane will follow upon the denuded surface, and so it may go on until a large cavity is made and lined.

The majority of persons who suffer from gangrene of the lung do not live for the formation of this cavity and clearing out of the dead matter; they sink from the depressing influences of the dead tissues within them. A few do recover, and the first mark of reparative action will be a sputum that contains purulent matter, a dirty green shreddy material which is the broken down debris of the lung still continuing. There is, in this period of healing, always great danger that the patient may die of hemorrhage. As this dead matter peels off, it may leave a vessel weak or even open. A good rule with reference to that point is, when persons are getting well, when they are showing an improved expectoration, to require them to be perfectly still; not to move any more than is necessary to get their food and their breath. In disobedience to this rule, a patient in this stage of the disease, at the hospital, some years ago, got up and went to the water-closet; he was doing well up to that time, but the effort was sufficient to cause a free hemorrhage, from which he sank. We made a post-mortem examination, and found that a part of the cavity which would have been left after removal of the dead lung, was lined with a pyogenic membrane. The remaining portions still had the dead lung attached to it, and it was at the border where the dead lung was being removed that this vessel was opened. As I said before, much the greater number of those who have gangrene of the lung die of it. Still, some do recover.

The treatment of gangrene of the lung is altogether sustaining; sustaining food, sustaining medicines. The alcoholics should be used carefully, given only by the pulse. When the pulse is small, frequent and feeble, then the alcoholics may help along a little. Quinine is one of the best remedies that we possess in this serious disease, and it should be given pretty freely, in eight or ten grain doses three times a day. It is a little antiseptic of itself, but its antiseptic properties are probably worth but little in this connection, because they hardly prevent the death of a portion of lung that is deprived of blood.

There is another point connected with this subject which I should not omit, and that is that the gangrenous lung excites inflammation about it. It is not uncommon when you cut into such a lung that you find there had been a pneumonia which seems to have been excited by the dead lung. There will be little pools of pus scattered through it, multiple abscess; not unfrequently it completely surrounds the dead portion. That I suppose has led to the conclusion that pneumonia ends in gangrene, I believe it never does. Gangrene may occur with pneumonia; it may occur in anybody in whose pulmonary arteries there is an obstruction which interferes with the flow of blood.

I think, from the light we have upon the subject now, that simple pneumonia never ends in purulent collections in the lungs. Still there are purulent collections in the lungs sometimes. But I believe they depend wholly upon an inflammatory action going on in some other part of the body, or rather, I should say upon a septicæmic action. If a part of the body is undergoing gangrene, even if it has no more of a gangrenous appearance than that molecular decay which occurs in ulcers, there may be a disordered action which will result in septicæmia and in the collection of purulent matter in the lung. The name most commonly given to such collections of pus in the lung is multiple abscess. Multiple abscess occurs in other organs besides the lungs, and perhaps in the liver more frequently than in any other. For example, the late Dr. Watts came and talked with me about a patient of his, a gentleman who had scarlet fever, and had it badly. In the course of the fever he had a very bad inflammation of the glands outside the tonsils. Two or three days after the doctor came to me and said his patient had chills. I said some considerable organ of the body has been poisoned from this inflammatory action in the glands. It turned out to be the liver, which was occupied by a large number of little abscesses, too numerous to count. One or two would be measured by inches. In a similar way where septic action is taking place in any part of the body, other organs than the liver may become the seat of these abscesses. Dysentery is rather the most common cause of this kind of disease of the liver. The purulent deposit of septicæmia is sometimes found in the joints, and in some it is found in muscles distant from the part that is primarily affected, but such deposits are always secondary. Here is a lung that has been thus affected. Not only have there been formed the collections of pus, but there is generally pneumonia also. This red portion is pneumonia, the yellow portions are collections of pus. The manner in which these purulent formations are produced is this: an embolus is brought from the affected part and lodges in the vessels of the lung, and beyond the point where this obstruction occurs from the lodgment of the embolus.

A kind of inflammatory action occurs the character of which is derived from the embolus. If that is septic, the inflammation of the lung is likely to be septic. The result is a production of pus commonly at numerous points. If you examine one of these points of inflammatory action before it has come to the full formation of pus you will find that it is very greatly congested, and that the tissues are softened, and if you cut into it you will find a little collection of pus in the center. In time that little collection of pus would have spread, and would have occupied in the end all the inflamed structure, making a little pool of pus. You may form an idea of the conditions under which these collections occur from a particular case. The first woman who was successfully treated by opium in puerperal peritonitis and metritis recovered with purulent collections in the lungs. After she was relieved of her puerperal disease, she began to cough. She was pale and feeble, her pulse very rapid, and she had something like a hectic fever. She was removed to a ward apart from the lying in wards, and was treated for a time with the idea that she had phthisis. But one day, seeing her and observing the expectoration, that it was unusually white for a tuberculous patient, I suggested to Dr. Cock, who was directing her treatment, that she was probably suffering from multiple abscess of the lung, and that the multiple abscess had been derived from her metritis, purulent metritis. She finally got well, entirely well, for I saw her two or three years afterward, and she had gained fifty or sixty pounds in weight. These multiple abscesses of the lung may, then, in certain instances, be relieved; the patient may recover. In general they do not. The diagnosis can be made mainly by the exclusion of phthisis. The expectoration is freer than it commonly is in phthisis, and the purulent matter that is discharged is of a considerably lighter color. Tubercles are most apt to be developed first under the clavicles, but multiple abscess is diffused through the lung. They may be under the clavicle, but they are just as likely, indeed more likely, to be in all other parts of the lung. A person who has had septicæmia and has free expectoration is very likely to have it produced by these multiple abscesses of the lung.

As to the treatment, it is, of course, sustaining all the way

through—sustaining, as far as diet goes, sustaining in regard to medicine; and as there is certain to be a hectic fever, quinine comes to be of the greatest service.

There is another form of disease of the lungs that I must call your attention to, and that is chronic pneumonia. It has no connection with the acute pneumonia that I have described. It affects another portion of the lung structures. The acute pneumonia, I told you, is an inflammation of the lining membrane of the air cells and alveolar passages; but a chronic pneumonia is an inflammation of the intercellular tissue, of the connective tissue that lies between and outside the cells. The connective tissue, in other words, of the lungs undergoes a change which I will try to describe to you. The changes are slow. The tendency is to contraction of the lung, a diminution of its size, and a hardening of its tissue, and a change of its color to a bluish hue. This change goes on in the same manner as in the liver when it becomes contracted in cirrhosis, a similar disease. This change in the lung has, therefore, sometimes been called cirrhosis of the lung. It is a bad name. The word cirrhosis is derived from the color which the liver takes on, yellow. The lung does not become yellow, but grayish blue. It may do for the sake of comparison to call it cirrhosis of the lung, but a much better name is that which I have used, chronic pneumonia. The term chronic pneumonia has been applied to unresolved pneumonia, cheesy pneumonia, but I do not think it a good use of the term. The lung, you understand, becomes small and of a bluish hue, and of a firm consistence; and all through there is a production, an increase, rather slowly, of fibrous elements in the inter-vascular structure. Persons who have a tendency to phthisis are more liable to this inflammation than others, and yet it may occur in other persons. In the progress of this disease, the lung contracting, the ribs follow it; the chest is diminished in size. This occurs only on one side. The ribs will follow the lungs as far as they can, but then the lungs contract still more, there will be an effusion of serum into the chest. It is not the result of inflammation; the pleuritic covering of the lung is hardly involved in this disease. It is an effusion of serum to fill a vacuum. You understand that "nature abhors a vacuum" and particularly so in the body of man, and to prevent it, therefore, the serous fluid of the blood is drawn out of the vessels to fill the space left by the contracting lung.

The duration of this disease is months. I have known a case terminate in three months; I have known cases continue nine months and more.

The indications of the disease are pretty clear after it is well established. For example, there is a cough from the beginning, and an expectoration of a muco-purulent matter; each particular sputum when thrown into water takes a rounded shape and does not unite with another. It is opaque and not very abundant as a rule. A chronic cough will naturally lead you to inquire if there is not tuberculosis. You should examine the lungs under both clavicles to ascertain whether there are not signs of tubercle. You will possibly find that there are none. However this may be, the signs of chronic pneumonia will be just as marked in the inferior and posterior portion of the lung as at the apex, always affecting only one side. But the marked point is reached when the serous effusion occurs. The lung contracting will give you a certain degree of dullness; then when it contracts to a degree that cannot be compensated for by the retracting ribs, will come this serous effusion, and as the patient sits in his chair or stands, the serum will always be below the lung. You get the physical signs of pleurisy with serous effusion, but you have not the other symptoms of pleurisy, you have not the pain. When that effusion occurs in a person who has been ill for two or three months, if there has been a gradually growing bronchophony and bronchial respiration, and a gradually growing dullness on percussion, you cannot well mistake the disease. If you cannot make your diagnosis previous to the effusion of the serum, you certainly can then. It is not a common disease. I have met perhaps with a dozen cases in my life time, and in most cases recovery has taken place, requiring, as I intimated, nearly a year in many cases, to run its course.

The treatment, again, is sustaining in as high a degree as you can well apply to the case. Counter-irritation I have always used, whether with benefit or not I can hardly say. Upon the affected side of the chest make an application of the tincture of iodine. This has been rather my favorite. Paint over the chest on a space as big as your hand with the tincture of iodine until it becomes painful. Then take another space of about the same extent next it, and then another and so on, painting each particular spot twice a day for about three days, when it will probably become sufficiently irritated. The patient should be encouraged to eat all the food he can digest, and in this way he may find his strength pretty well sustained. The medicines that give strength, the tonics, are those that you rely on chiefly. Unless the patient has tubercles there is a pretty good chance for his recovery.

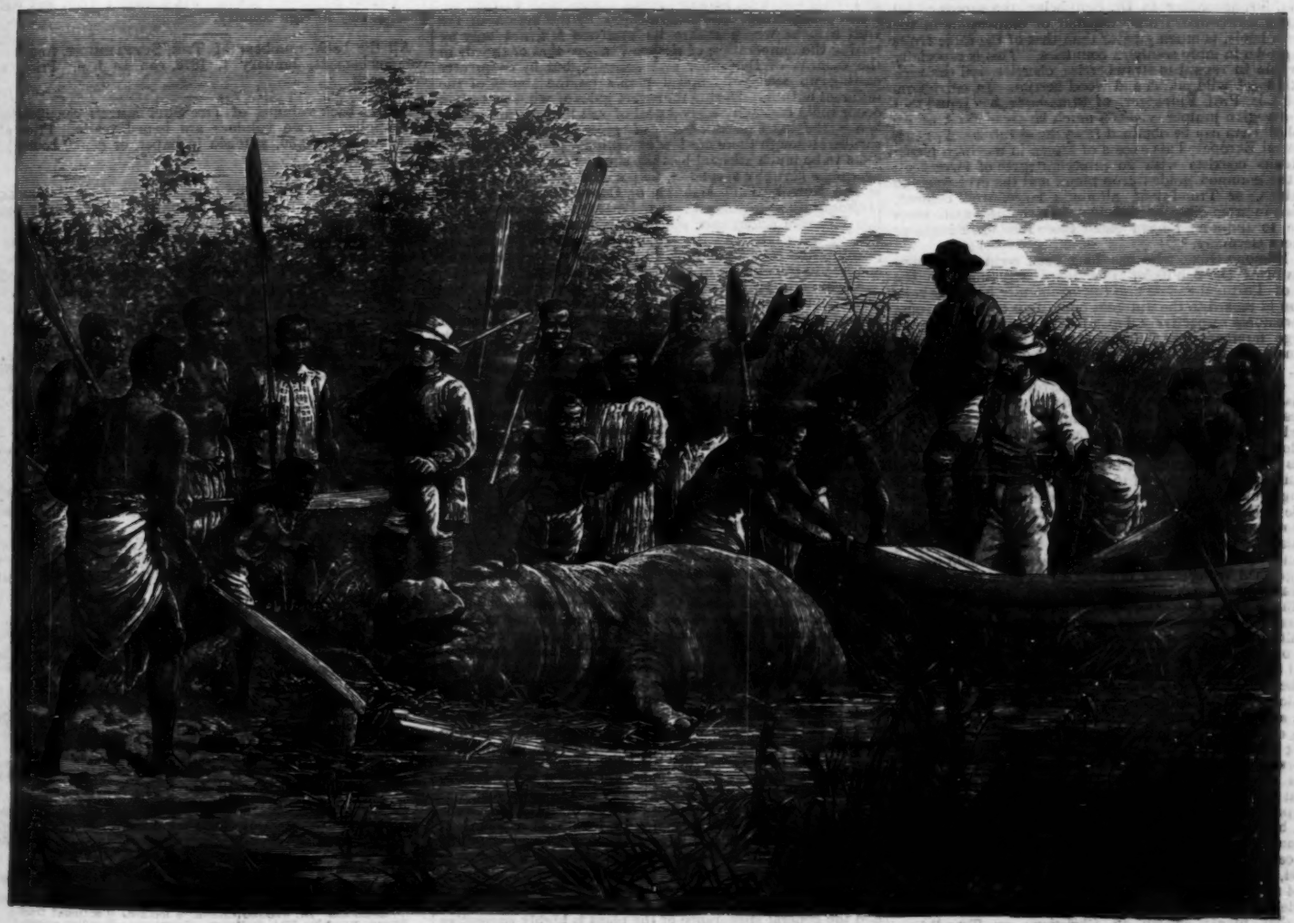
HINTS FOR THE SICK ROOM.

SOMEWHERE lately I read that in some country house where milk was in plenty, a pan of it was placed near meat in the larder to keep the latter fresh. I am sorry to be so lame in my story, but the principle to be carried out was that milk, being a ready absorbent, the bad air that would otherwise have tainted the meat flew to the milk instead. My thoughts immediately reverted to the sick room, where milk is often left standing for the use of the invalid, and it occurred to me that if this were the case would it not just as readily absorb the poisonous exhalations that arise there? Why, or how, I am not chemist enough to explain, but—as most persons are aware—water is a rapid absorbent of the taint of paint; and in a room freshly painted, a pail of clean, cold water left standing there will quickly "take off the smell." Dip your finger into the water which has been thus left all night, you will find it tastes strongly of the paint. Milk is too costly to be thus largely used, but a little—say a saucerful—might be placed for experiment, and if it tastes of the paint you may reasonably conclude that it would taste just as much (certainly absorb just as readily) of whatever impurities hang round a sick bed when left standing near it.

Let me impress upon invalids the importance of keeping their refreshments covered. Many delicate persons not absolutely in need of night attendance yet require a supply of night nutriment. I know of an invalid home where almost every patient is regularly supplied with a glass of milk at the bedside for night use. Then there are cooling drinks, jellies, blancmanges, and a variety of liquids usually seen at the invalid's bed side, and all more or less absorbent All should be kept covered. I once visited an invalid who had her bedside table supplied with an array of glasses, cups, tumblers, etc., the contents of not one of which could we see, all being covered with a most amusing variety of glass and porcelain lids. The invalid liked to forget the contents of each, and was amused to lift one or another of the tiny covers and select a refreshment which presented itself to her taste. And to keep invalids amused, and ready to relish what is provided for them, are important duties in nursing. Such slight attentions cost little trouble, while the sufferer feels that he or she is tenderly cared for.—*Land and Water.*

AFRICAN HIPPOPOTAMUS HUNTING.

THE huge beast which has obtained, in Greek, the inappropriate name of river-horse, but looks more like a river-hog, and is of the same family as the elephant, rhinoceros, and tapir, abounds in the rivers of tropical and semi-tropical Africa, but may also be found in certain gardens of the Regent's Park, London, N.W. "H.R.H.," that is to say, His Rolling Hulk, the title bestowed on this illustrious foreigner, by Charles Dickens, in *Household Words*, upon his arrival in England some quarter of a century ago, has become a tolerably familiar object of admiring contemplation among us; he has received our frequent kind inquiries and congratulations upon the health of his wife and family, and has been made to feel himself quite at home. It is pleasant to observe a little girl of five or six years boldly venturing to cast a bun or an apple into his enormous gaping mouth, which is shaped like the opening of an immense leather traveling bag, but is furnished with a terrific array of gleaming tusks and oblique protruding incisors. These are not intended, we believe, to share the luncheon of gentle English children, but rather for tearing up and chewing the grass and weeds and aquatic plants in the Central African rivers, the Nile or the Congo, anywhere from Nubia to Angola, or to the borders of our Colonial Kaffirland. The traveler who has moored his canoe or boat to the river bank at night, in hope of needful repose and slumber, will be very likely kept awake by the tumultuous sound of gurgling and snorting from all the waters that flow or spread over the plain for many miles around him; and, if one of the big brutes should happen to swim that way, it is quite possible that the canoe may suddenly be upset, or even crunched by the jaws of the playful monster. A herd of twenty or even thirty of these animals is frequently met with together, but half of them will be under water, so it is not easy to count the precise number. The hunter's first endeavor is to separate one from the herd, and then he gets a shot at it with his large elephant rifle, using an explosive shell instead of a bullet. His native servants and followers are much pleased by his killing a hippopotamus, from which they cut plenty of fat meat.—*Illustrated London News.*



HIPPOPOTAMUS HUNTING IN ANGOLA, WEST AFRICA.

ALUMINUM SULPHATE.—This salt, though always open to the objection of variability of constitution as it reaches the market, has been made of better quality of late than in former years, more nearly definite in character and freer from iron. Especially is this true of the so-called "porous alum" made from kryolite. Under the name "alum clay cake," that made from clay and still retaining silica in admixture with it, finds extensive use among paper makers and for some of the less refined processes of dyeing, and is manufactured upon an increasing scale, both for such direct use and for conversion into alum.

THE EFFECTS OF UNINTERRUPTED SUNLIGHT ON PLANTS.

PROF. SCHUBELER, of Christiana, who for nearly thirty years has been engaged in observing the influence exerted by differences of climate on vegetation, has published the result of his observations in recent numbers of our Norwegian namesake, *Nature*. The first of the series of his observations, which he has given in detail, refer to winter wheat, and were undertaken with the special view of noting what effect the almost unbroken sunlight of the short Scandinavian summers had on plants raised from foreign seed. The experiments were made with samples of grain from Bessarabia and Ohio, and in both cases it was found that the original color of the grain gradually acquired each year a richer and darker color—the difference being perceptible even in the first year's crop—until it finally assumed the yellow-brown tint of other home-grown Norwegian winter wheats. Similar results were obtained with maize, different kinds of garden and field peas and beans, and certain other garden plants, as celery, parsley, etc. In no case has Dr. Schübeler found that an imported plant, capable of being cultivated in Norway, loses in intensity of color after continued cultivation; while in regard to many of the common garden flowers of Central Europe, he believes it may be asserted with certainty, that after their acclimatization in Norway, they acquire an increase of size, as well as an augmentation of color. These altered conditions are more forcibly manifested the further north we go within the limits of capacity of vegetation for different plants. Thus it has been observed by Prof. Wahlberg, of Stockholm, that *Epilobium angustifolium*, *Lychnis sylvestris*, *Geranium sylvaticum*, and many other plants common to Lapmark and the more southern districts of Sweden, attain in the former a size and brilliancy of tint unknown in the latter. The change in the case of *Veronica serpyllifolia* and *Trientalis europea* is remarkable; the former changing as it goes further north from a pale to a dark blue, and the latter from white to rose-pink. It is noteworthy that a tinge of red is a common characteristic of the vegetation of the Scandinavian Fjælds; this being observable alike in blue, yellow, green, and white colors.

Color is not, however, the only property affected by the unbroken continuance of daylight in the summers of Scandinavia, for, according to Dr. Schübeler, the aroma of all wild and cultivated fruits, capable of cultivation in the northern lands, is much greater than that of the same fruits when grown in more southern countries. This is especially observable in regard to strawberries, cherries, and the various kinds of wild marsh and wood berries. In corroboration of this, Prof. Flückiger, of Strassburg, has found that the Norwegian juniper yields a much larger amount of essential oil than can be obtained from the shrub when grown in Central Europe. This excess of aroma in northern plants and fruits coexists with an inferior degree of sweetness; thus, the common golden-drop plum, and the greengage of Christiana, or Trondhjem, although large, well colored, and rich in aroma, are so deficient in sweetness as to seem unripe to those who have eaten these fruits in France or Southern Germany.

Dr. Edmond Göse, who has long been resident at Coimbra, informs Dr. Schübeler that his observations on the fruits of Portugal enable him to corroborate that observer's opinion in regard to the different conditions on which aroma and sweetness respectively depend. The strawberries grown in large numbers near Coimbra are, he says, of great size, extremely sweet, but almost wholly deficient in aroma and flavor. The same remark refers to the Portuguese wines, when compared with the highly flavored yields of the Rhenish and other northern vineyards; and a consideration of these varying conditions leads him to accept as an established fact, that light bears the same relation to aroma as heat does to sweetness.

This increase of aroma, or intensification of flavor, due to the uninterrupted action of the sun's light, has the effect of making some of our most savory garden plants almost uneatable in Scandinavia. Thus, Dr. Schübeler has found that common white stick-celery, which had been grown near Christiana with careful attention to the methods followed in England, and which in outward appearance could not be distinguished from plants brought direct from Covent Garden Market, had a sharp, unpleasant taste, when compared with the milder and more agreeably flavored English plants. The same result was observed in garlic, shalots, and onions, and although it must be admitted, that as the expressions of mere individual taste, the writer's conclusions in regard to this point are open to doubt, it should at the same time be borne in mind that they are based on practical observations and experiments, continued for nearly thirty years, and confirmed by the concurrent testimony of several of his colleagues, who, like himself, were desirous of deducing practical results from the acclimatization of plants in Norway. From this point of view, some of Dr. Schübeler's observations are especially interesting and in the present low condition of Norwegian industrial development, their practical application would be highly important. Thus, he shows that while linseed oil is obtained in Holland, Germany, and Middle Russia in the proportion of about 3 or 4 per cent. of the weight of the plants from which it is extracted, the yield from uncultivated plants in Norway varies from 4 to 5, or 5 to 8 per cent. Again, his experiments of the yield of the essential oil of lavender have convinced him that plants grown in Christiana or Trondhjem, when compared to those grown near Merton, which have hitherto been regarded as the first in the world, greatly excel the latter in aroma, and he considers that the cultivation of this plant could be carried on with undoubted success on the coast lands of Norway.

While Dr. Schübeler has no hesitation in maintaining that light engenders aroma, as heat engenders sweetness, he has not been able to determine to what extent the vegetable alkaloids are affected by either. In connection with his own observations, he reports some curious particulars in regard to the action of continuous light in the polar regions, which he has obtained from intelligent residents, who had undertaken to conduct certain experiments under his direction. Thus, it was found, both at Alten in West Finmark, and at Stamsund in the Lafodens, that plants of *Acacia lophantha* never contracted their leaves during the two months or longer, that the sun remained above the horizon. An experiment was made at Alten to shade one half of the crown of an acacia during the night, and the result was that in about twenty minutes' time the protected leaves began to contract, and remained closed until the plant was again wholly exposed to the midnight sun, when after a time the leaves began slowly to unfold. At Stamsund it was observed that whenever the acacias were placed on the north side of a house, which was partially screened by a neighboring fjeld, the leaflets turned upward, without, however, wholly closing, and the same thing was noticed in rainy weather. The leaves of *Mimosa pudica* contracted in the lightest and clearest nights, and remained folded back for some hours.

Without entering further into the details of Dr. Schübeler's numerous experiments, we may summarize their results as follows:

1. The grain of wheat, that has been grown in low lying lands, may be propagated with success on the high fjælds, and will reach maturity earlier at such elevations, even although at a lower mean temperature. Such grain, after having been raised for several years at the highest elevation which admits of its cultivation, is found when transferred to its original locality to ripen earlier than the other crops which had not been moved. The same result is noticeable in grain that has been transported from a southern to a more northern locality, and *vice versa*.

2. Seeds imported from a southern locality, when sown within the limits compatible with their cultivation, increase in size and weight, and these same seeds, when removed from a more northern locality to their original southern home, gradually diminish to their former dimensions. A similar change is observable in the leaves and blossoms of various kinds of trees and other plants. Further, it is found that plants raised from seed, ripened in a northern locality, are hardier as well as larger than those grown in the south, and are better able to resist excessive cold.

3. The further north we go—within certain fixed limits—the more energetic is the development of the pigment in flowers, leaves, and seeds. Similarly, the aroma, or flavor of various plants or fruits, is augmented in intensity the further north they are carried within the limits of their capacity for cultivation; conversely, the quantity of saccharine matter diminishes in proportion as the plant is carried further northward.—*Nature*.

NEW ZEALAND FLAX IN ORKNEY.

DR. W. TRAILL gives the following results of an attempt to introduce the *Phormium tenax* into the Orkney Islands, in a paper read before the Botanical Society of Edinburgh last December: These islands, from their high latitude—59° north—enjoy comparatively little heat in summer, though their winters are remarkably mild, there being little snow and frost, which is, perhaps, partly attributable to their insular position, but is chiefly caused by the action of the Gulf Stream, which makes its presence felt, not only by raising the temperature of the sea 7° above that of the air in the months of December and January, but by frequently casting up seeds of tropical plants on the shores of the different islands. During the severe gales of wind that often occur there is usually a good deal of salt in the atmosphere, hence the extreme difficulty of growing trees, or even shrubs, although there are few exceptional plants that do not seem to be much affected by this, such as different kinds of evergreen shrubby veronicas, and a few other plants, such as the New Zealand Manuka, or Captain Cook's tea plant (*Leptospermum scoparium*), the *Pernettya mucronata*, and the Japanese Euonymus, etc., which, favored by the mildness of the winters, thrive remarkably well, and to all appearance the New Zealand flax lily is likely to prove as well adapted to the climate of Orkney as any of them.

About eight years ago, or rather more, I got some of the seeds from a friend in New Zealand, which I raised in a hotbed in St. Andrew's, and during the same season I planted out several of them in the open air in my garden at North Ronaldshay, Orkney, where they have remained ever since, with no protection beyond the proximity of a low wall, some having a southern exposure and others an eastern aspect. These plants seem in no way affected by the winter, except that the tips of their leaves become somewhat frayed and ragged, but in the course of the following summer they soon recover their beauty, and they have gradually increased in size, until the leaves on some plants now measure from 5 to 6 feet, and in others from 6 to 7 feet long.

It was not until the first week of June, 1879, that my plants showed any signs or flowering, but I then observed that (of the three largest plants) two were throwing out each two flower shoots; the third and largest plant, however, produced no fewer than five flower stalks, enveloped by long sheathing leaves that closely embraced the stems, which were at this time from 4 to 5 feet high; the upper part, which evidently contained the future flower, being inflated, and tapering to a point at the apex, not unlike the head of a spear. They increased in length at the rate of about an inch a day; the swollen mass of spathes separating, successively unfolding, revealing numerous bunches of flower buds, until, when the stem reached the length of 8 to 9 feet, there were twelve or fourteen distinct clusters of flower buds of a purplish-brown color, disposed alternately on each side of the stem. The spathes at this stage added much to the effect, their interior being of a deep orange color. Our weather had been rather dry for some time, which seemed to retard the opening of the buds; but after a heavy shower of rain on August 1 the buds rapidly increased in size, and in three or four days the first flowers opened; they were tubular in shape, 1½ or 2 inches in length, of a deep red color, with projecting orange stamens. The odor of the flowers was powerful, like that of Russia leather. It seemed to be very attractive to bees, moths, and other insects. Each main stem bore at least 300 flowers. Altogether it is a most magnificent example of the lily family, and the general appearance of the plant is highly suggestive of tropical vegetation. It is well known that the fiber of the leaves possesses extraordinary tenacity, though, from its containing a large quantity of silica in its composition, the economic value of the plant has hitherto fallen short of what was at first expected. For the manufacture of ropes and cordage, however, I should think it most valuable. The leaf, even in its natural state, is so strong and pliable that I have seen strips of it torn off and used as boot laces, and it is evident that the flower stalks partake of the same tough character as the leaves, as they were not at all damaged by the equinoctial gales of last September, though they were not tied to sticks or otherwise secured from injury. I may add that the flowers, after lasting for some two months, were succeeded by numerous seed capsules containing apparently well-ripened seeds.

A NEW VEGETABLE FROM CHINA.

SOME experiments recently carried on by two or three Austrian and German horticulturists have brought into notice an almost forgotten plant which was introduced into Europe from China nearly thirty years ago, but whose existence and whose products have been undeservedly lost sight of. This is the *Soja hispida*, a species of leguminous plant, somewhat resembling in habit and appearance the well-known pea. Unlike the latter, however, it has two distinct uses—industrial as well as alimentary. It is highly prized in China and Japan, and is said, indeed, to take its specific title from the Japanese name of a sauce-sooja—which is made from its seeds. The seeds are very similar to a "marrow-fat" pea, but contain a large quantity of oil, which is either pressed out of them or boiled out in process of cooking the seeds for the table, which is effected by simply throwing them into boiling water, when the other skin bursts and floats to the surface, together with a quantity of oil, but the oil and the husks being skimmed off together. The oil may be either used as cattle food, or the oil may be separated and employed for various purposes, while the husks are still valuable as a feeding stuff or as a manure.

The peas are boiled for about twenty minutes, and form a dish which is highly relished, not only by the Celestials, but by the Europeans who have tasted it. It is said to resemble in flavor the green pea, but lacks its sweet taste. The boiled *soja* is also prepared as a cake and as a sauce, being fermented for the latter purpose, and salt, pepper, etc., being added. The sauce has a high reputation among the Chinese and Japanese, not merely as a condiment, but as a medicinal agent. Chemical analysis of the seeds shows them to be very rich in proteine. The oil is available for many uses—for burning in lamps or even as a substitute for olive oil. Being somewhat of a siccative nature it is well adapted for a lubricant, but is for that reason useful as a substitute for linseed oil in the manufacture of paints and in other similar industrial arts. Finally, to complete the list of virtues of this Celestial pea, the haulm gives an excellent fodder for cattle and horses.—*London Globe*.

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